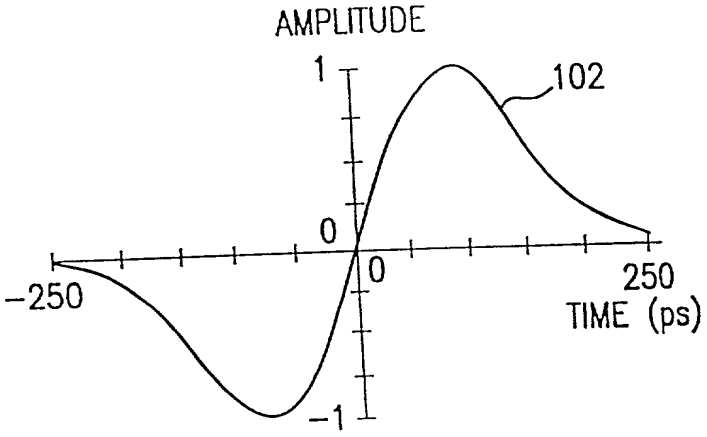
AMPLITUDE
1
0
-1
-250
0
250
TIME (ps)
102

FIG. 1A

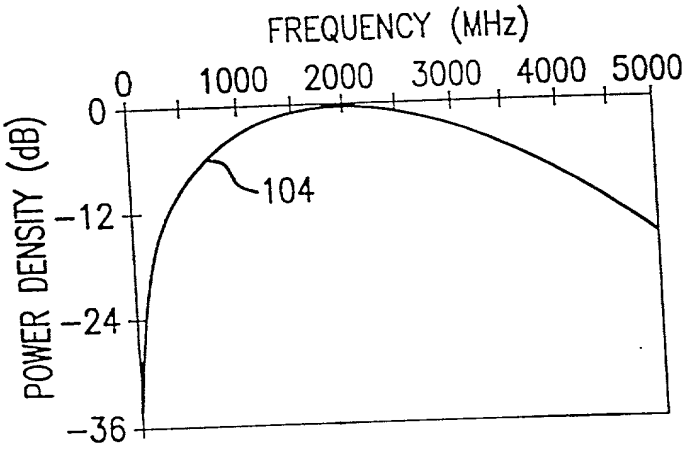
FREQUENCY (MHz)
0
1000
2000
3000
4000
5000
POWER DENSITY (dB)
0
-12
-24
-36
104

FIG. 1B

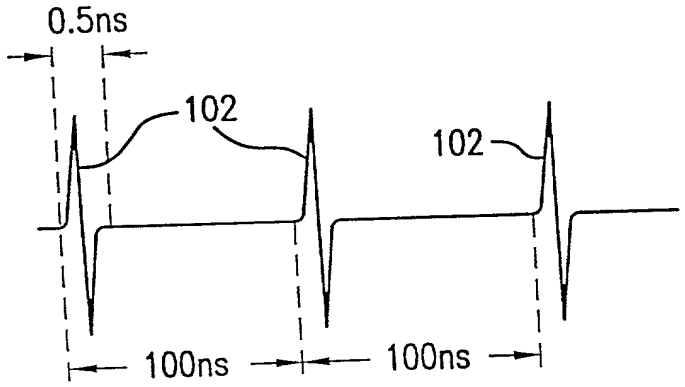
0.5ns
102
102
100ns
100ns

FIG.2A

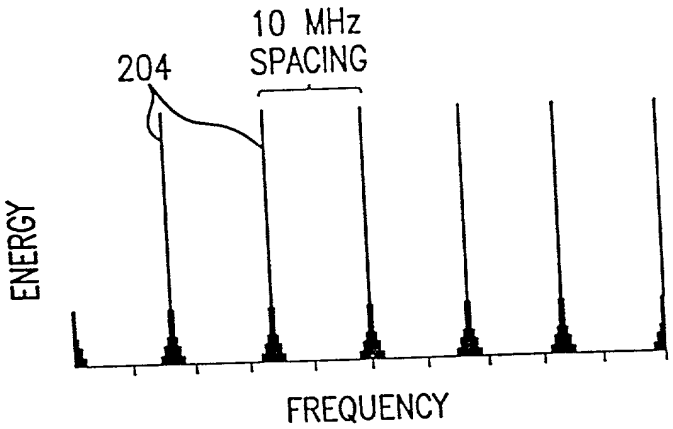
10 MHz
SPACING
204
ENERGY
FREQUENCY

FIG.2B

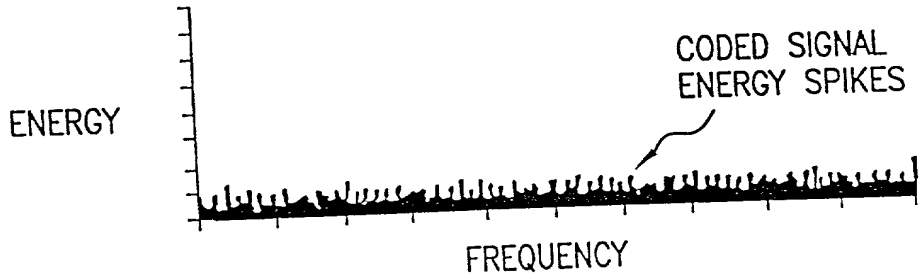

FIG.3

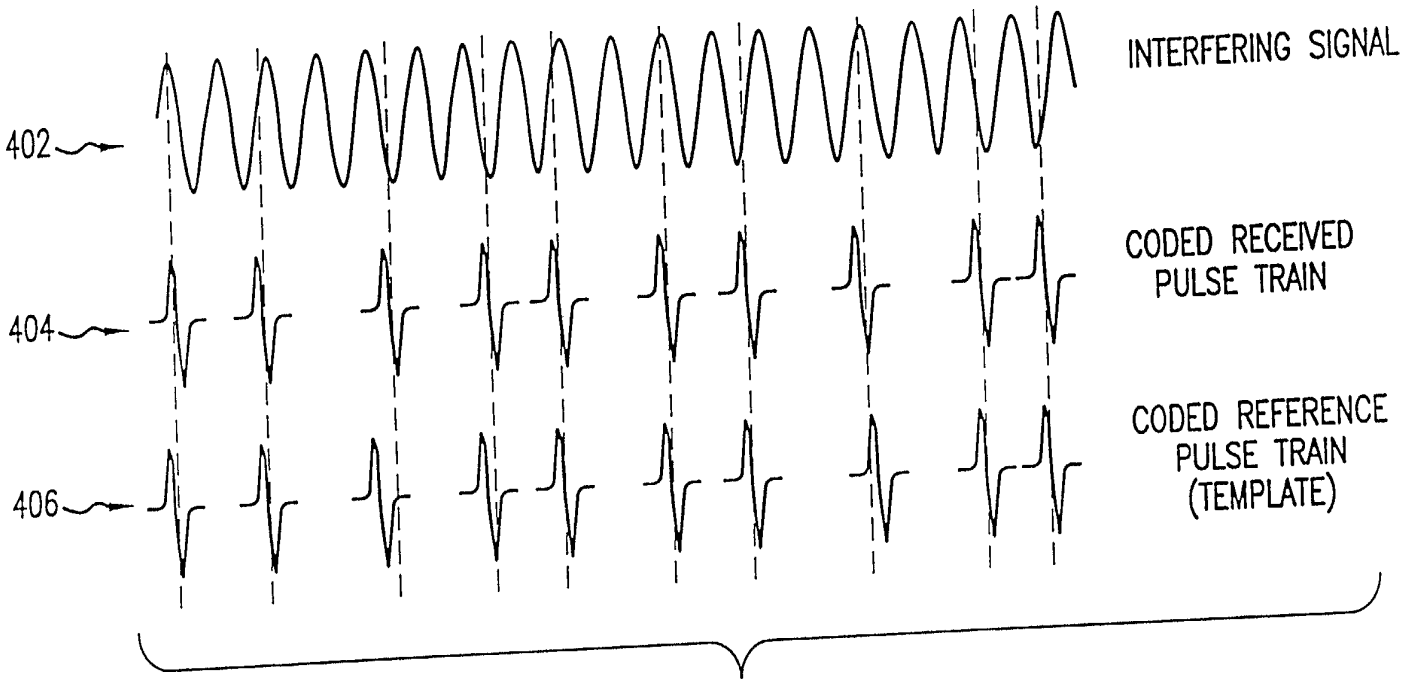
INTERFERING SIGNAL
402
CODED RECEIVED PULSE TRAIN
404
CODED REFERENCE PULSE TRAIN (TEMPLATE)
406

FIG.4

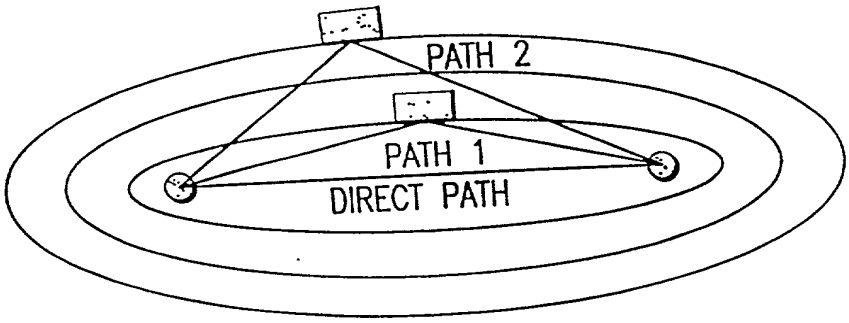
PATH 2
PATH 1
DIRECT PATH

FIG.5A

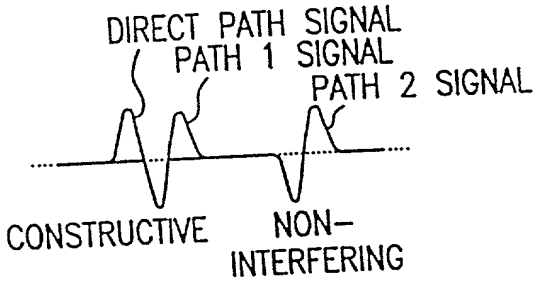
DIRECT PATH SIGNAL
PATH 1 SIGNAL
PATH 2 SIGNAL
CONSTRUCTIVE
NON-
INTERFERING

FIG.5B

TOSHIBA 21852

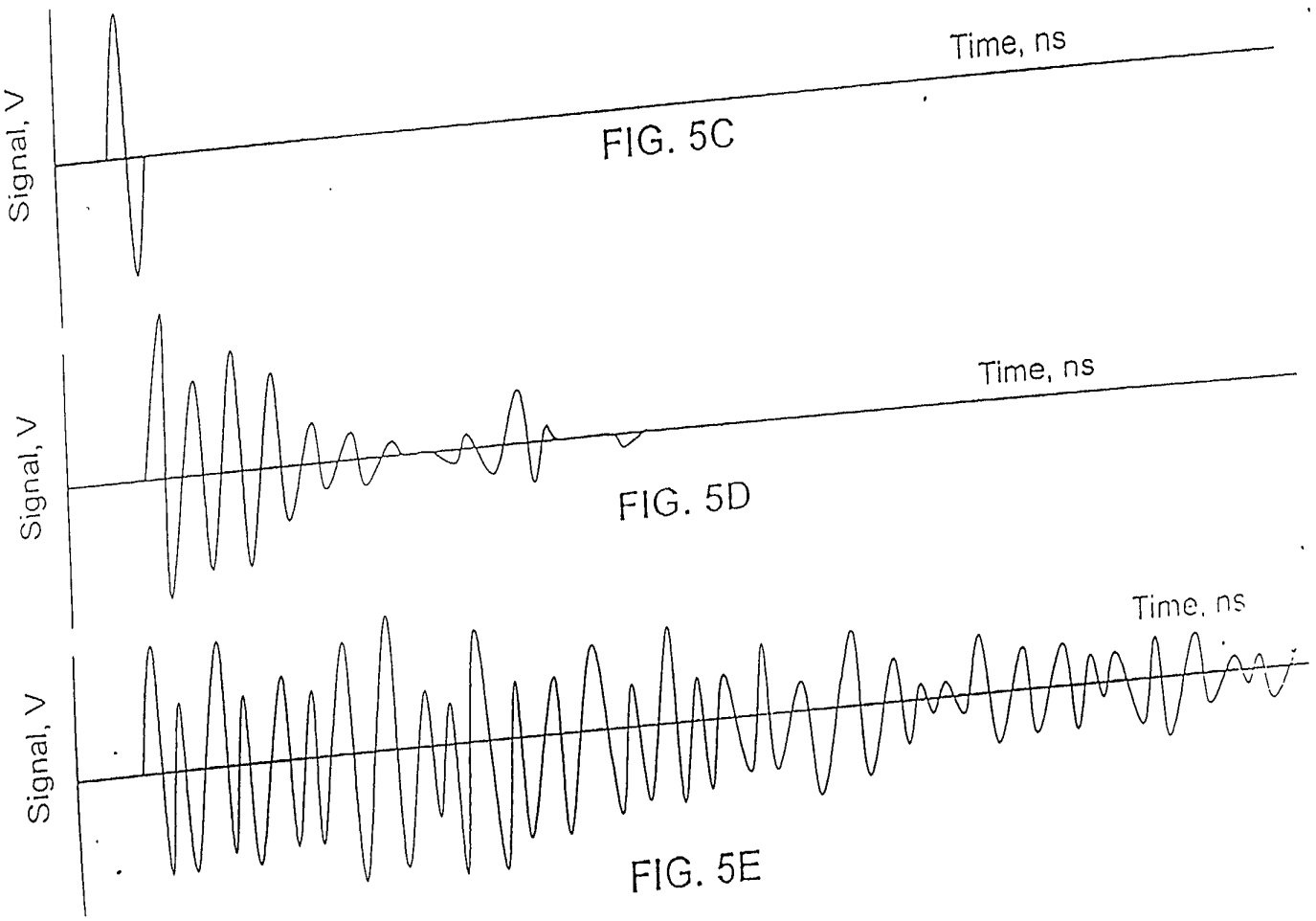

FIG. 5C

FIG. 5D

FIG. 5E

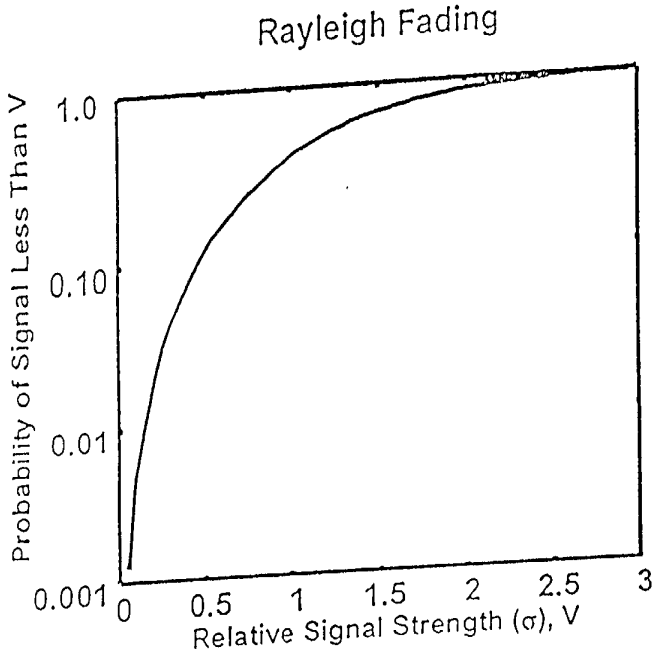
Rayleigh Fading
Probability of Signal Less Than V
1.0
0.10
0.01
0.001
0
0.5
1
1.5
2
2.5
3
Relative Signal Strength (σ), V

Fig. 5F

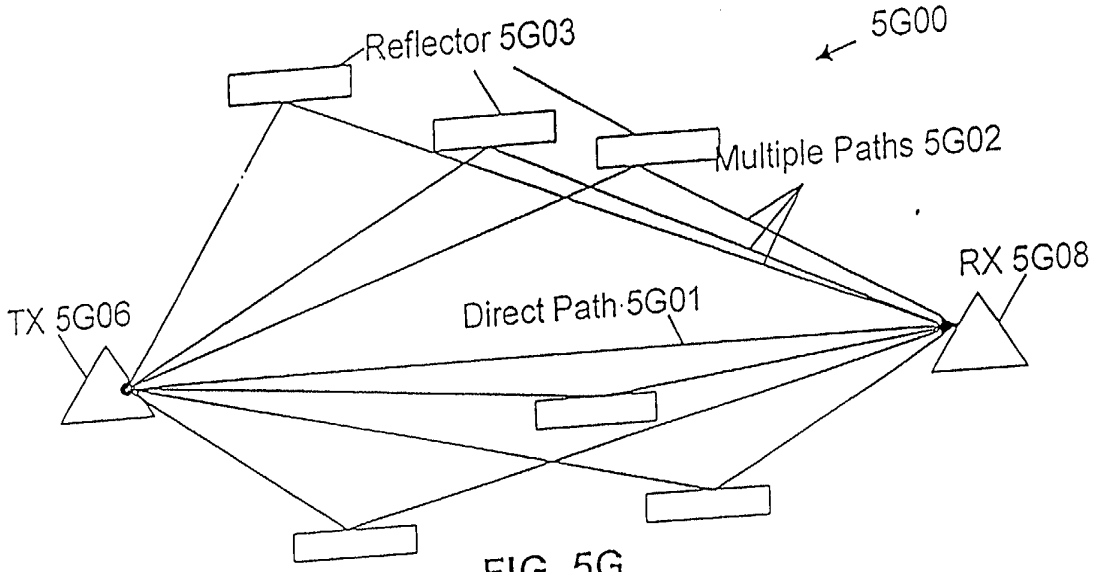
Reflector 5G03
5G00
Multiple Paths 5G02
RX 5G08
TX 5G06
Direct Path 5G01

FIG. 5G

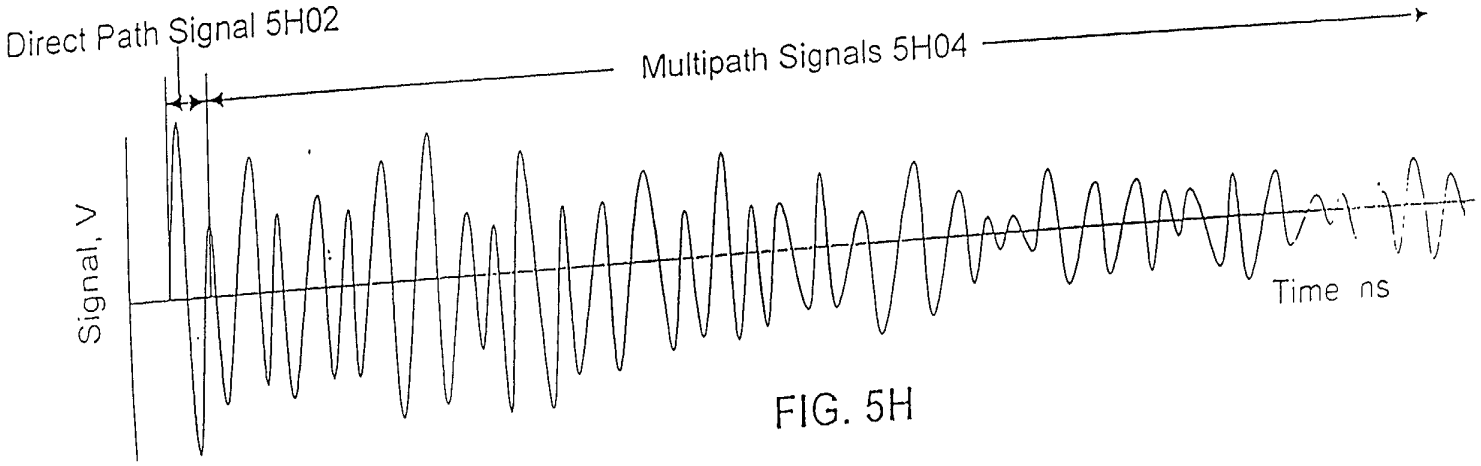
Direct Path Signal 5H02
Multipath Signals 5H04
Signal, V
Time ns

FIG. 5H

Tabcorp Exhibit 2

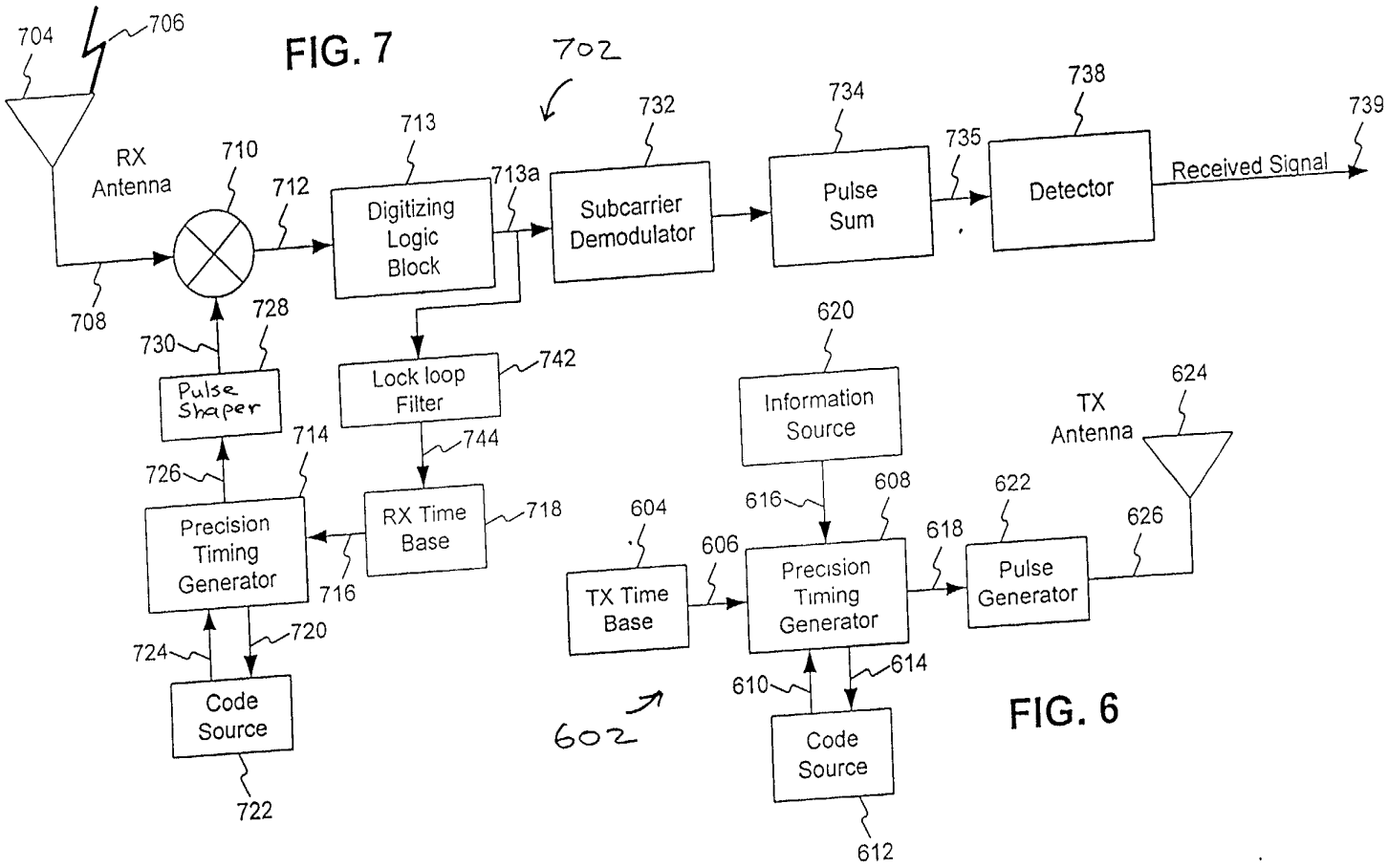

FIG. 7

FIG. 6

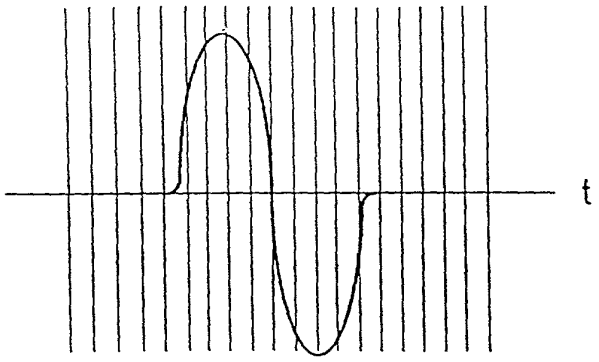

FIG.8A

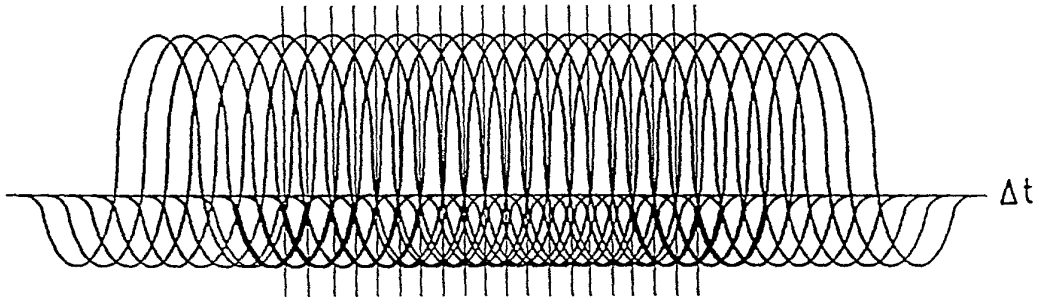

FIG.8B

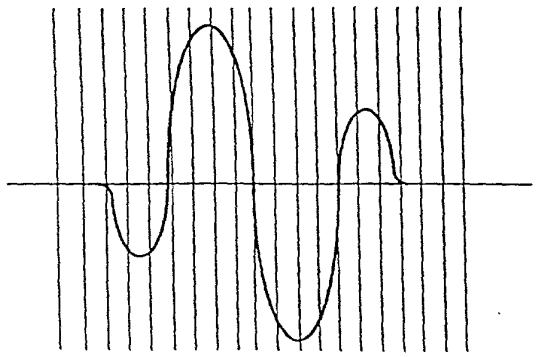

FIG.8C

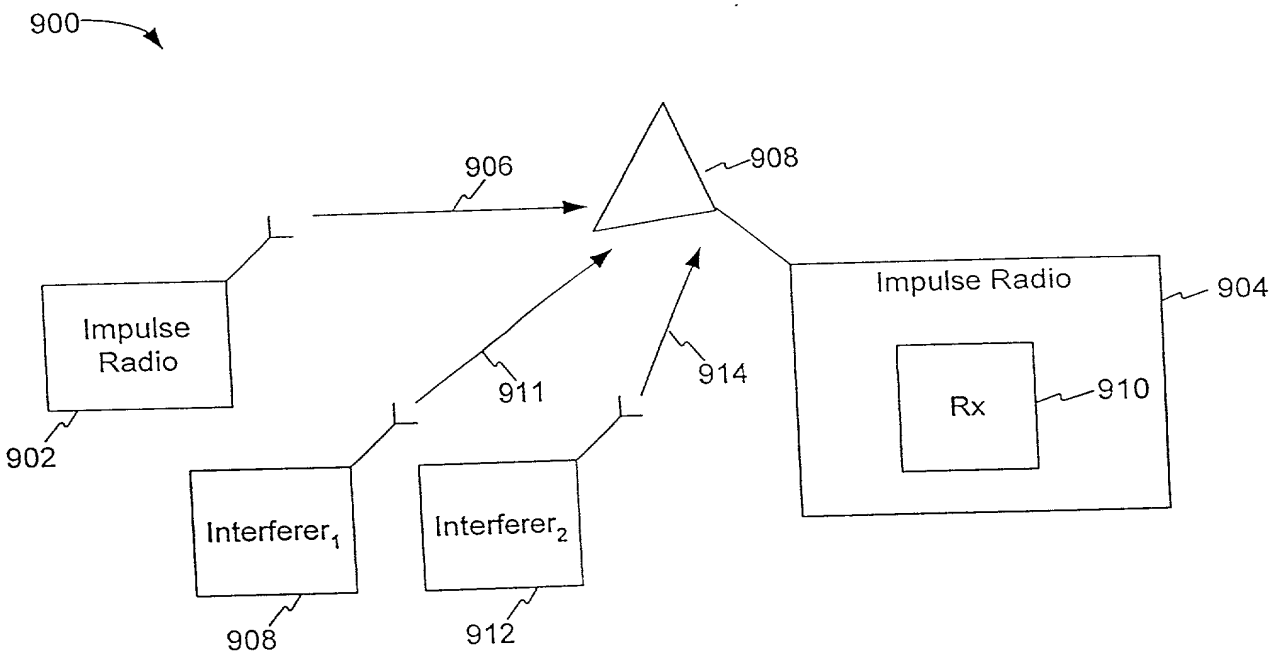

FIG. 9

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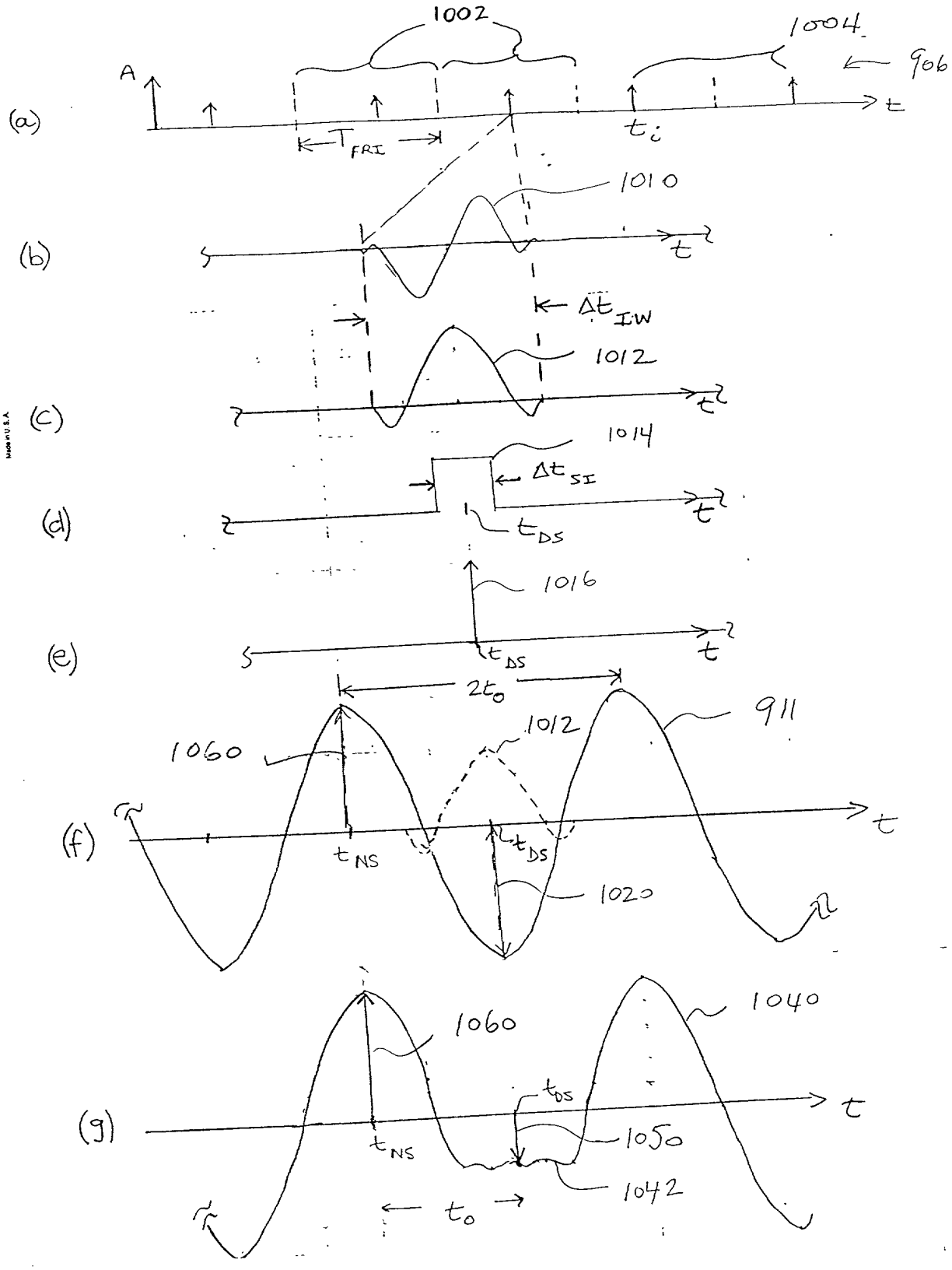

1002
1004
906
A
(a)
t
T_{FRI}
t_i
1010
(b)
t
Δt_{IW}
1012
(c)
t
1014
Δt_{SI}
(d)
t
t_{DS}
1016
(e)
t
t_{DS}
$2t_0$
911
1012
1060
(f)
t
t_{NS}
t_{DS}
1020
1040
1060
(g)
t
t_{DS}
t_{NS}
1050
1042
t_0

FIG. 10

FIG. 11A

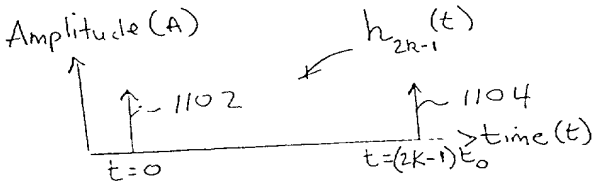


FIG. 11B

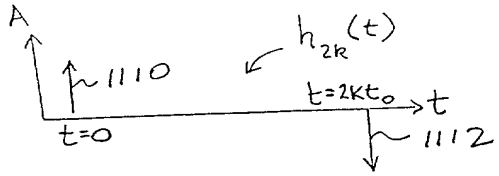
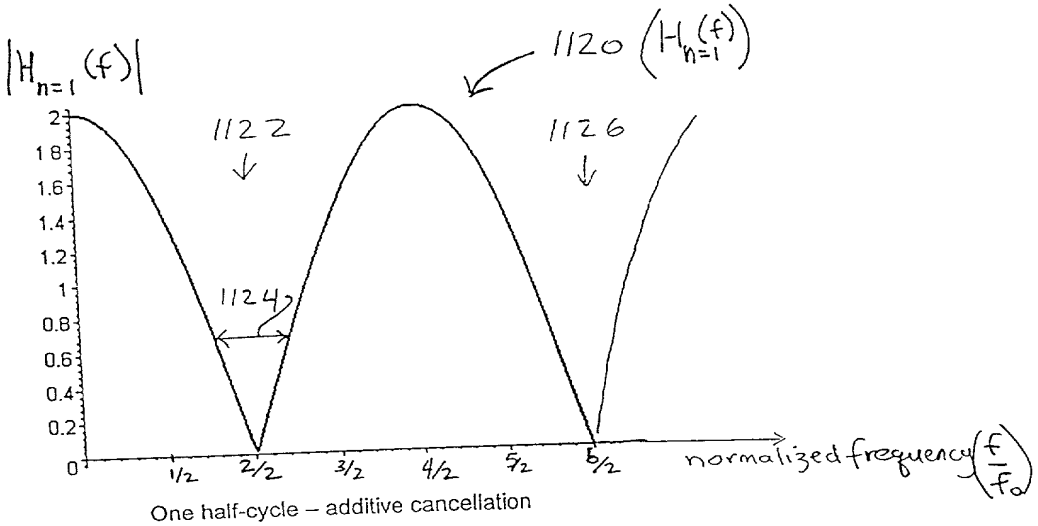
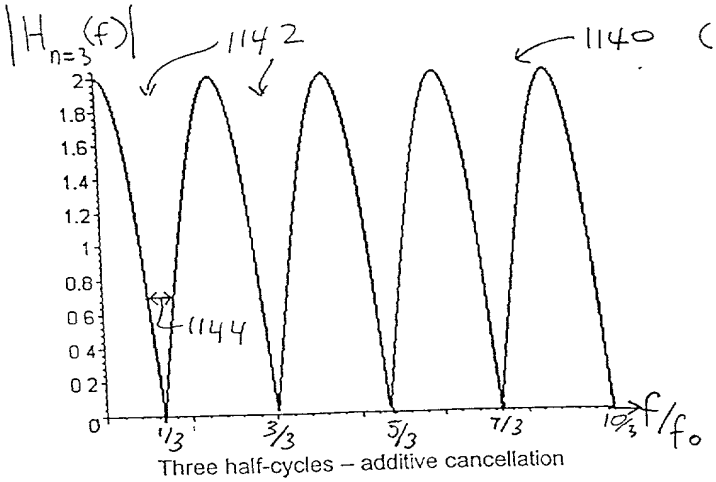


FIG. 11C



One half-cycle – additive cancellation

FIG. 11D



Three half-cycles – additive cancellation

FIG. 11E

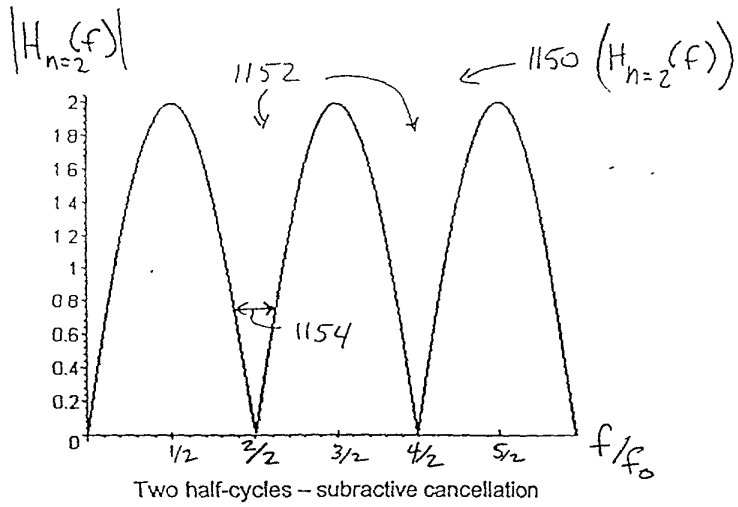


FIG. 11F

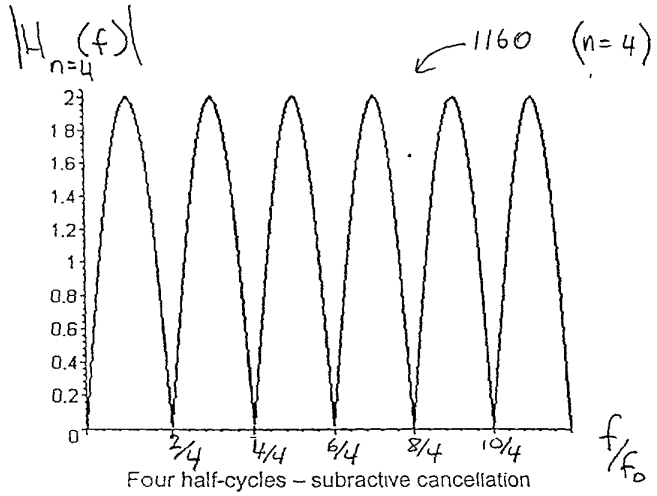


FIG. 11G

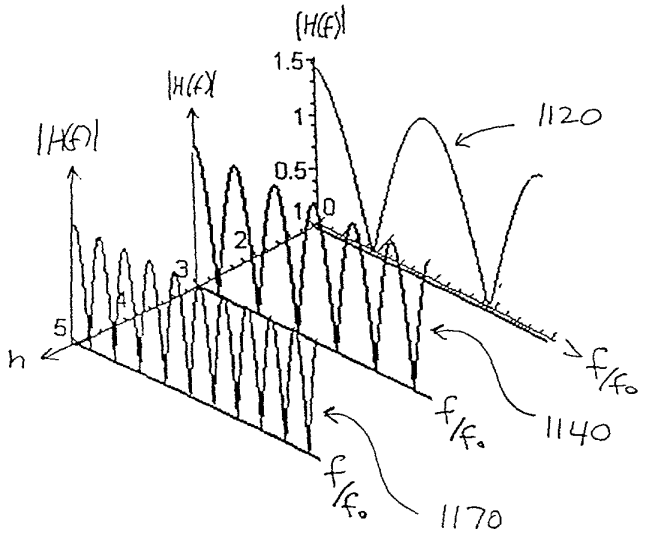
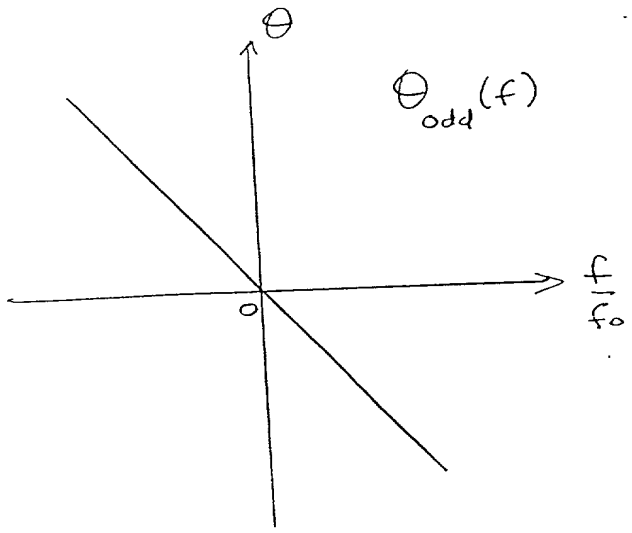
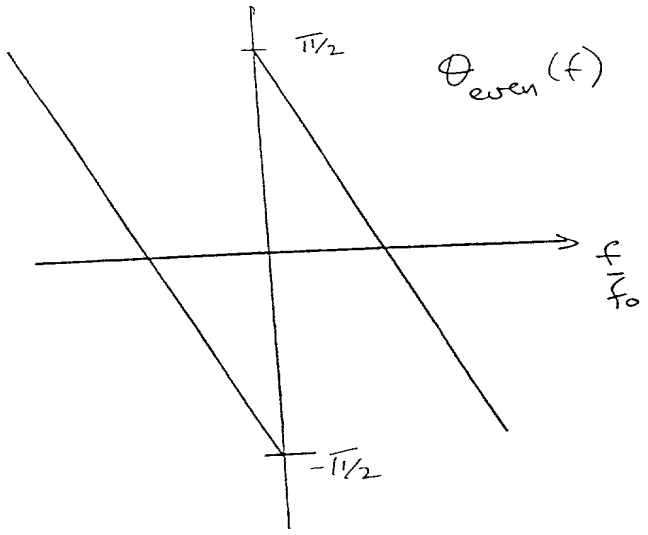


FIG. 11H



Phase response when n is odd

FIG. 11I



Phase response when n is even

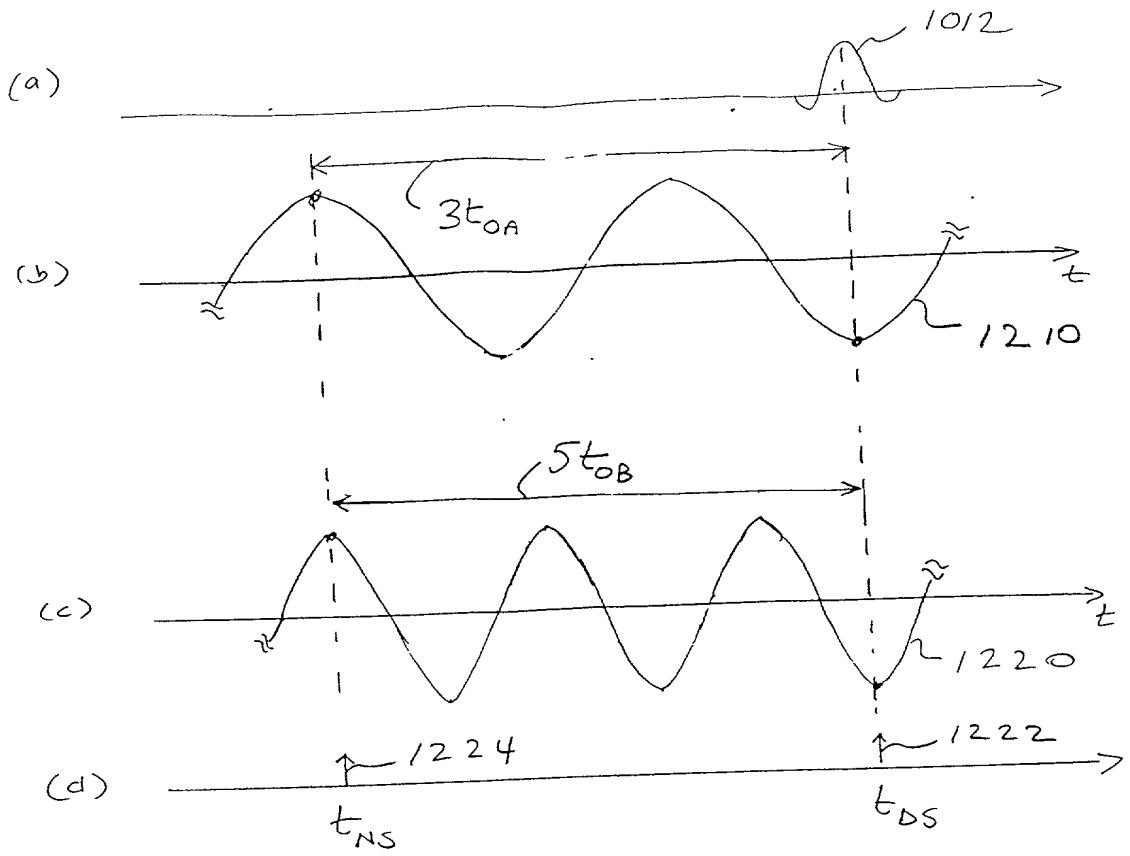
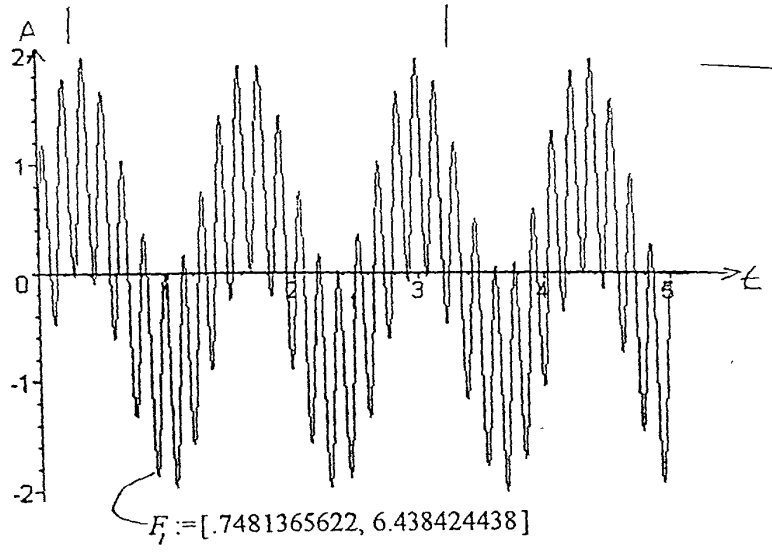


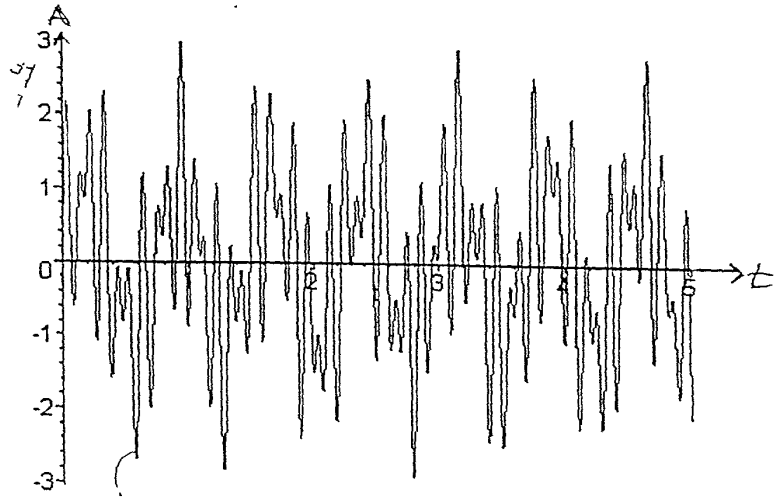
FIG. 12

FIG. 13A.



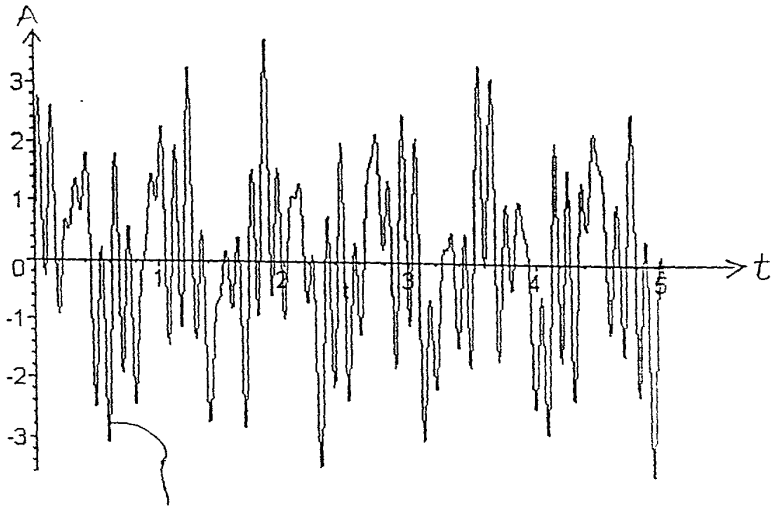
F_1 :=[.7481365622, 6.438424438]

FIG. 13B



F_2:=[6.720753584, 1.355371088, 9.916381555]

FIG. 13C



F_3:=[8.252407886, 9.918985673, 1.168817937, 3.408077283]

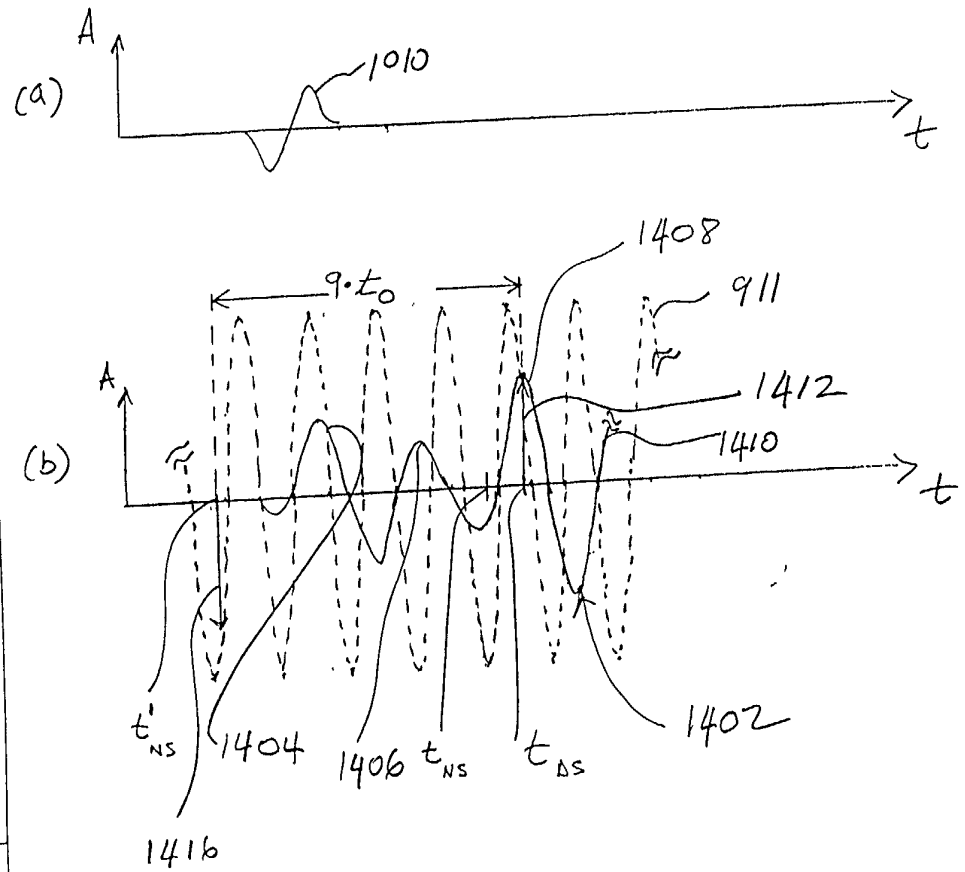

(a)
A
1010
t
(b)
A
9·t0
1408
911
1412
1410
t
t'NS
1404
1406
tNS
tDS
1402
1416

FIG. 14

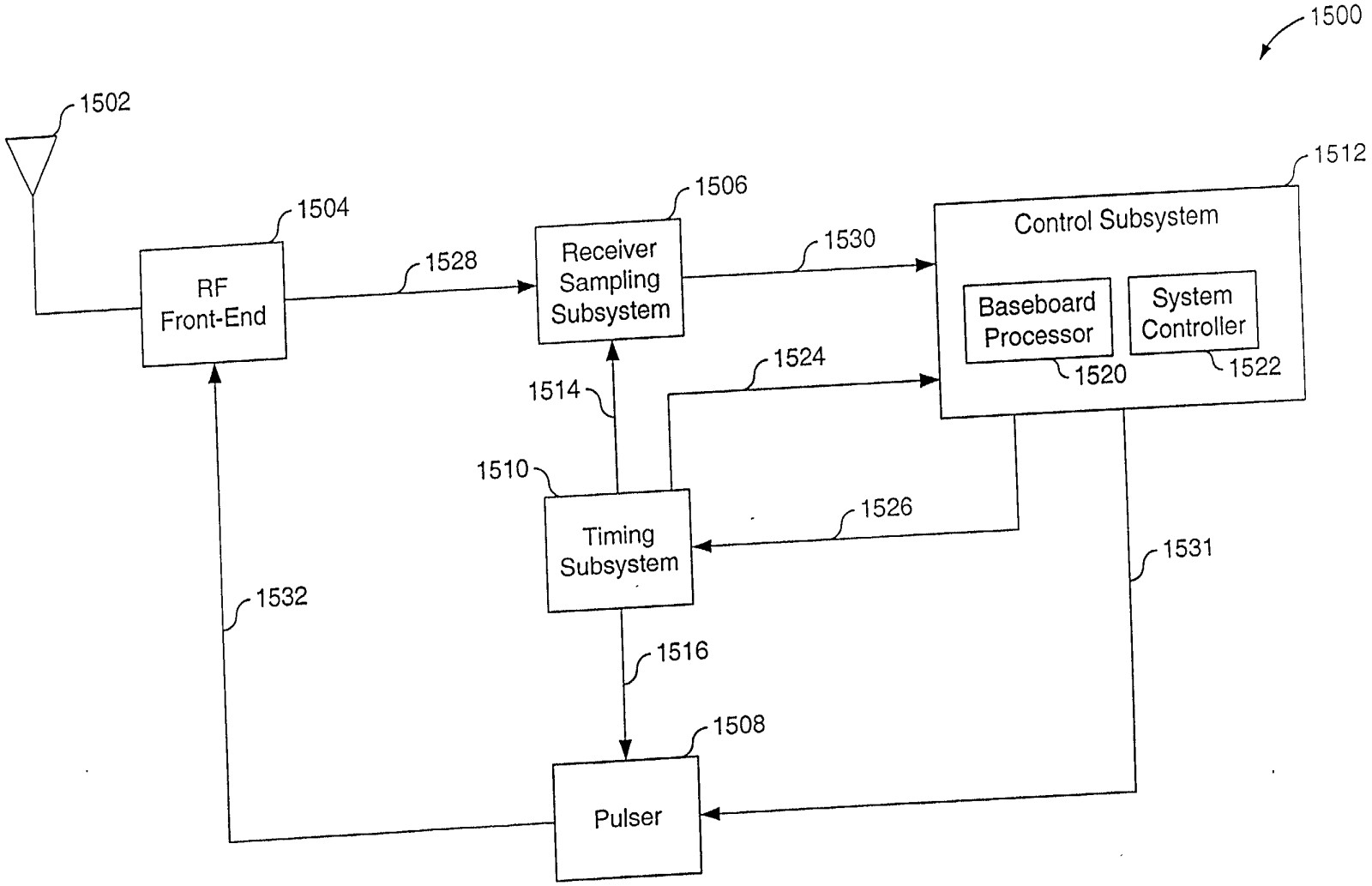

1500
1502
1504
RF
Front-End
1528
1506
Receiver
Sampling
Subsystem
1530
1512
Control Subsystem
Baseboard
Processor
1520
System
Controller
1522
1524
1514
1510
Timing
Subsystem
1526
1531
1532
1516
1508
Pulser

FIG. 15

FIG. 16

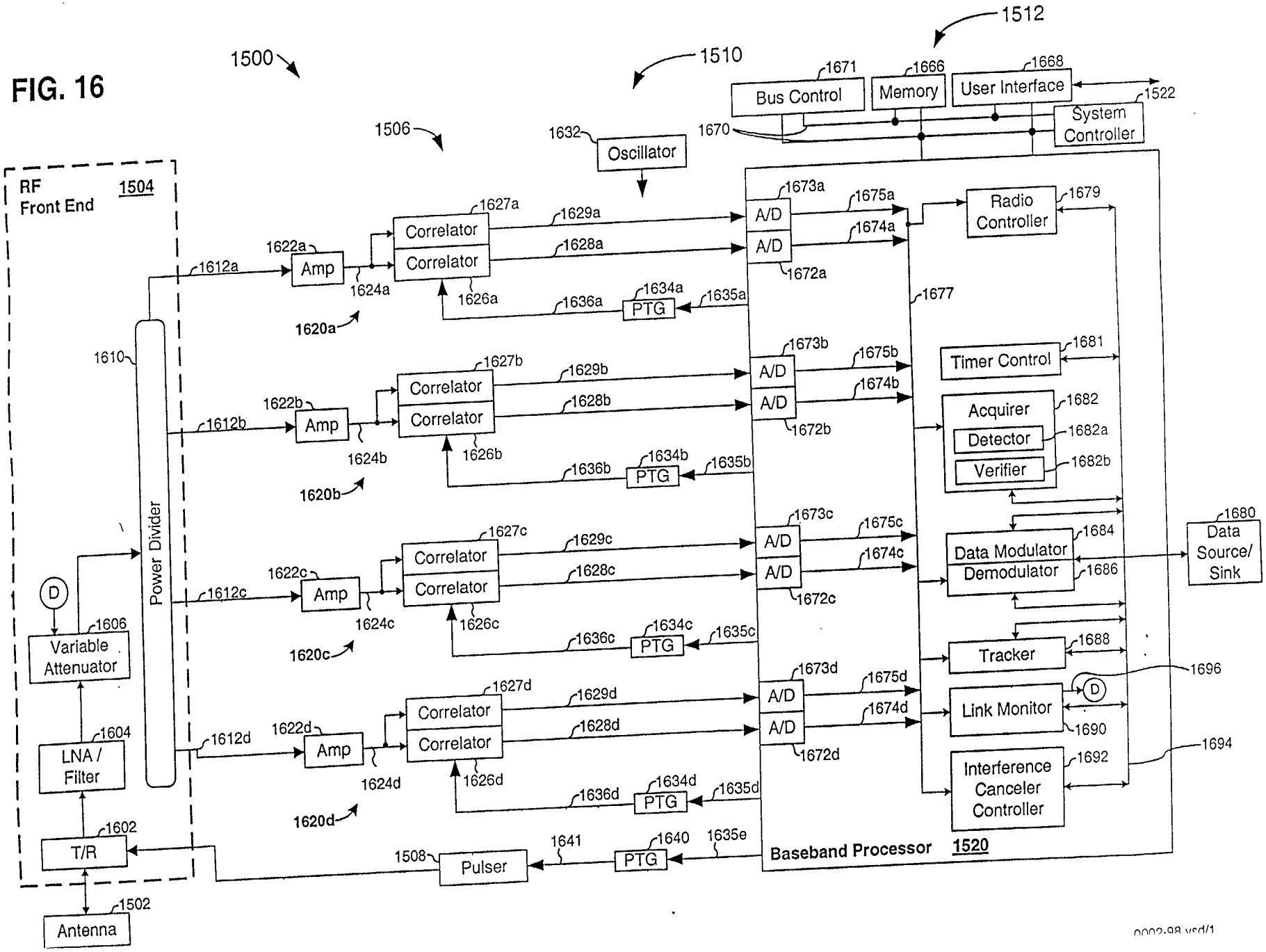

1500
1510
1512
1506
1632
Oscillator
1671
Bus Control
1666
Memory
1668
User Interface
1522
System Controller
1670
RF Front End
1504
1610
Power Divider
1612a
1612b
1612c
1612d
1622a
1622b
1622c
1622d
Amp
1624a
1624b
1624c
1624d
1620a
1620b
1620c
1620d
1627a
1627b
1627c
1627d
Correlator
1626a
1626b
1626c
1626d
1629a
1629b
1629c
1629d
1628a
1628b
1628c
1628d
1634a
1634b
1634c
1634d
PTG
1635a
1635b
1635c
1635d
1636a
1636b
1636c
1636d
1673a
1673b
1673c
1673d
A/D
1672a
1672b
1672c
1672d
1675a
1675b
1675c
1675d
1674a
1674b
1674c
1674d
1677
Radio Controller
1679
Timer Control
1681
Acquirer
1682
Detector
1682a
Verifier
1682b
Data Modulator
Demodulator
1684
1686
1680
Data Source/ Sink
Tracker
1688
1696
Link Monitor
1690
Interference Canceler Controller
1692
1694
Baseband Processor
1520
1640
1641
1635e
1508
Pulser
D
1606
Variable Attenuator
1604
LNA / Filter
1602
T/R
1502
Antenna

FIG. 17A

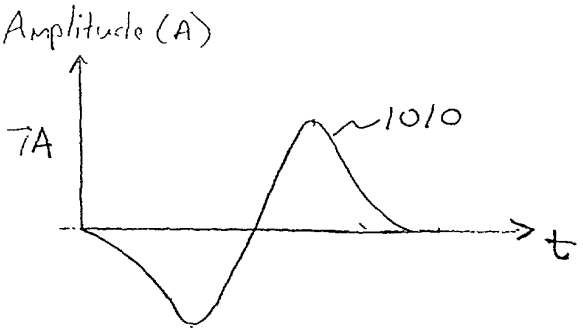
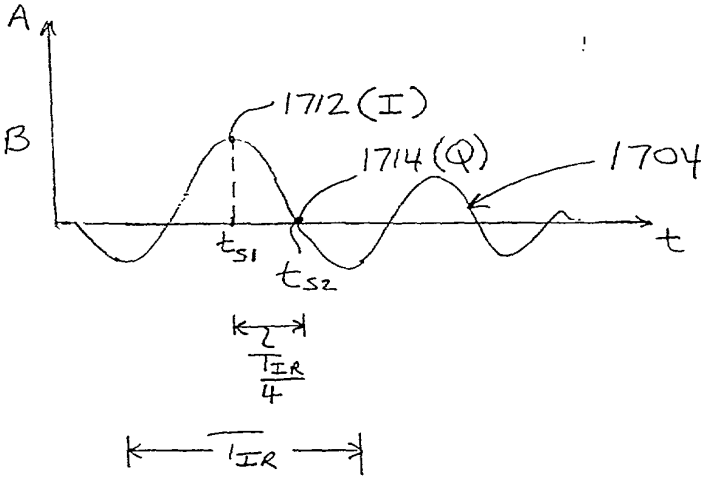


FIG. 17B



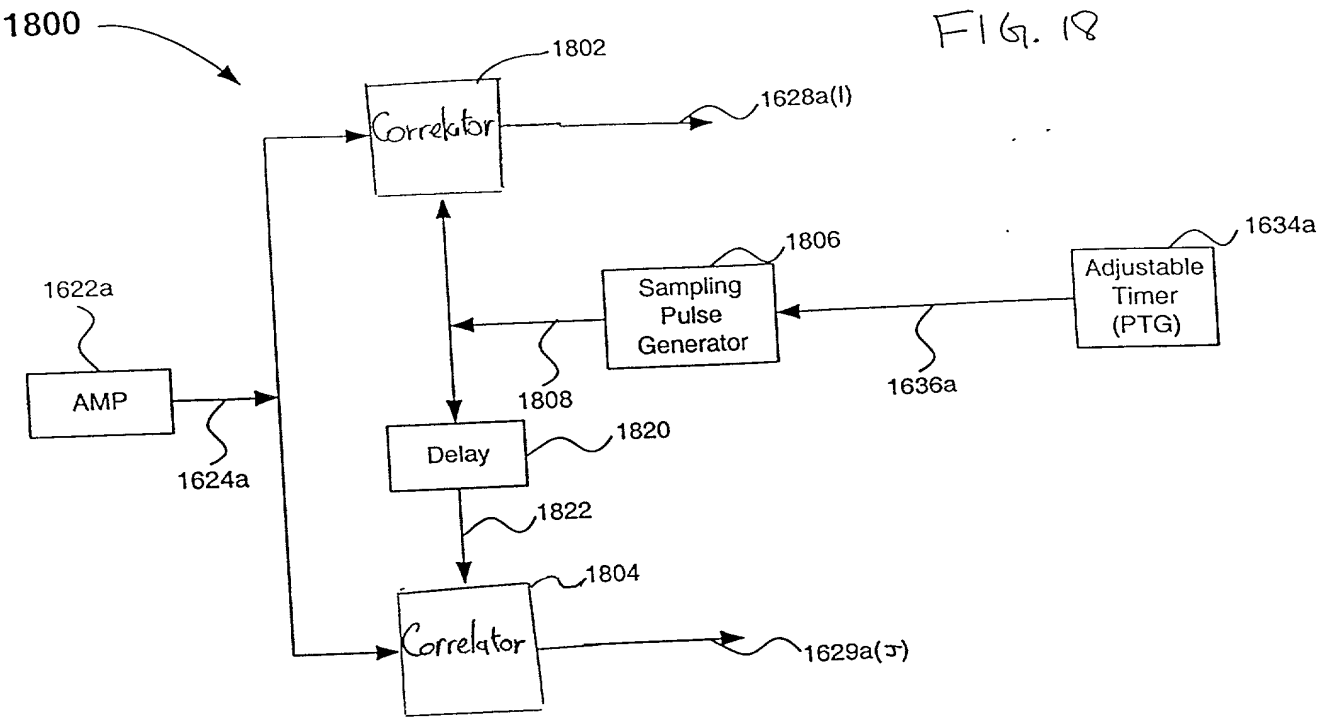


FIG. 18

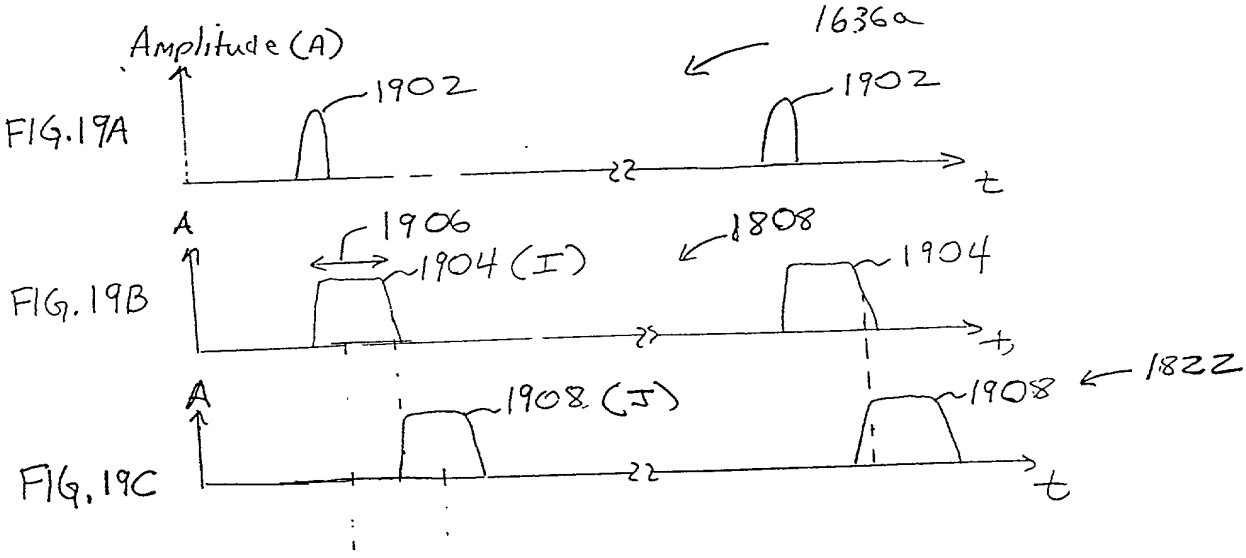


FIG. 19A

FIG. 19B

FIG. 19C

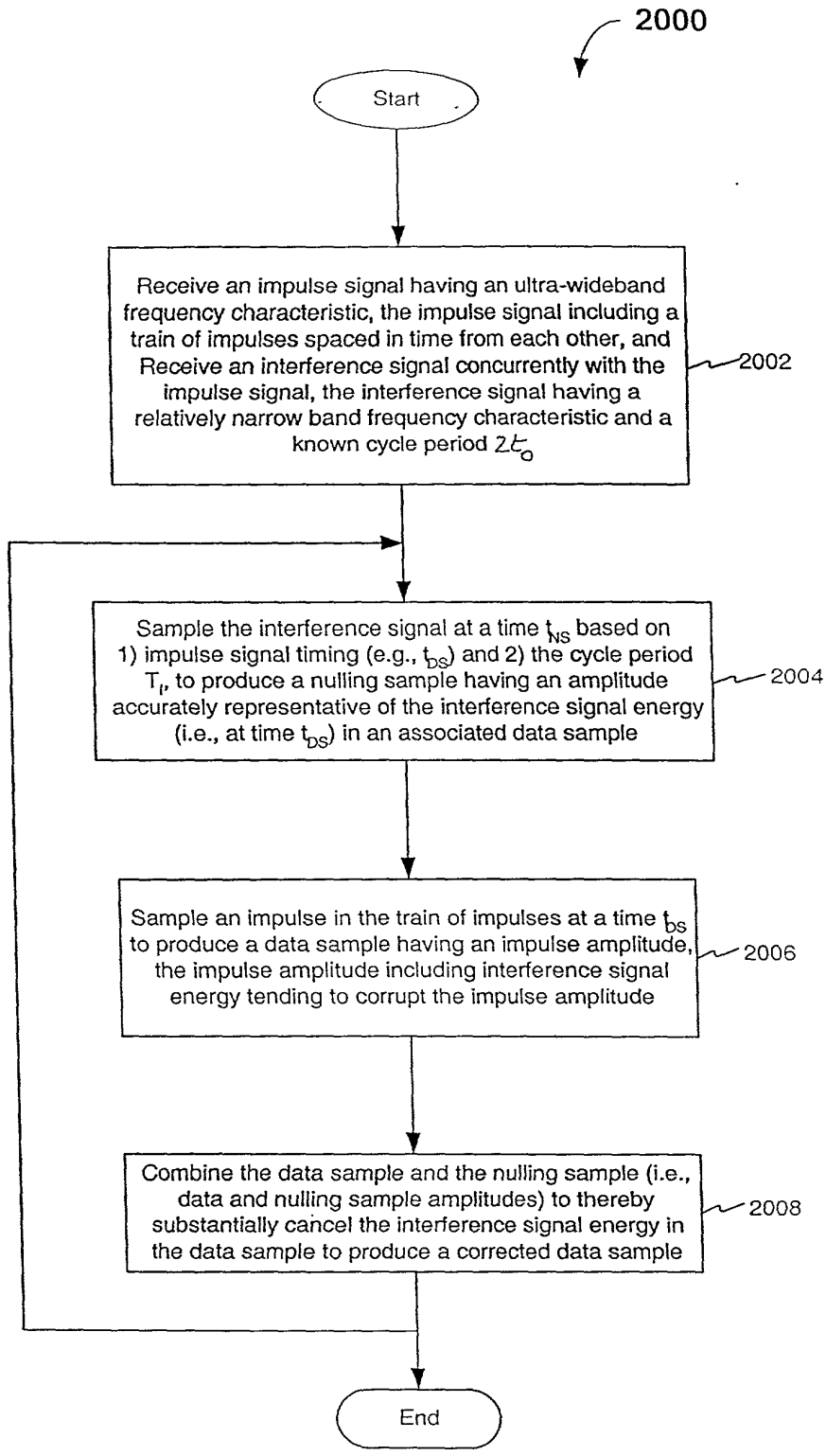


FIG. 20

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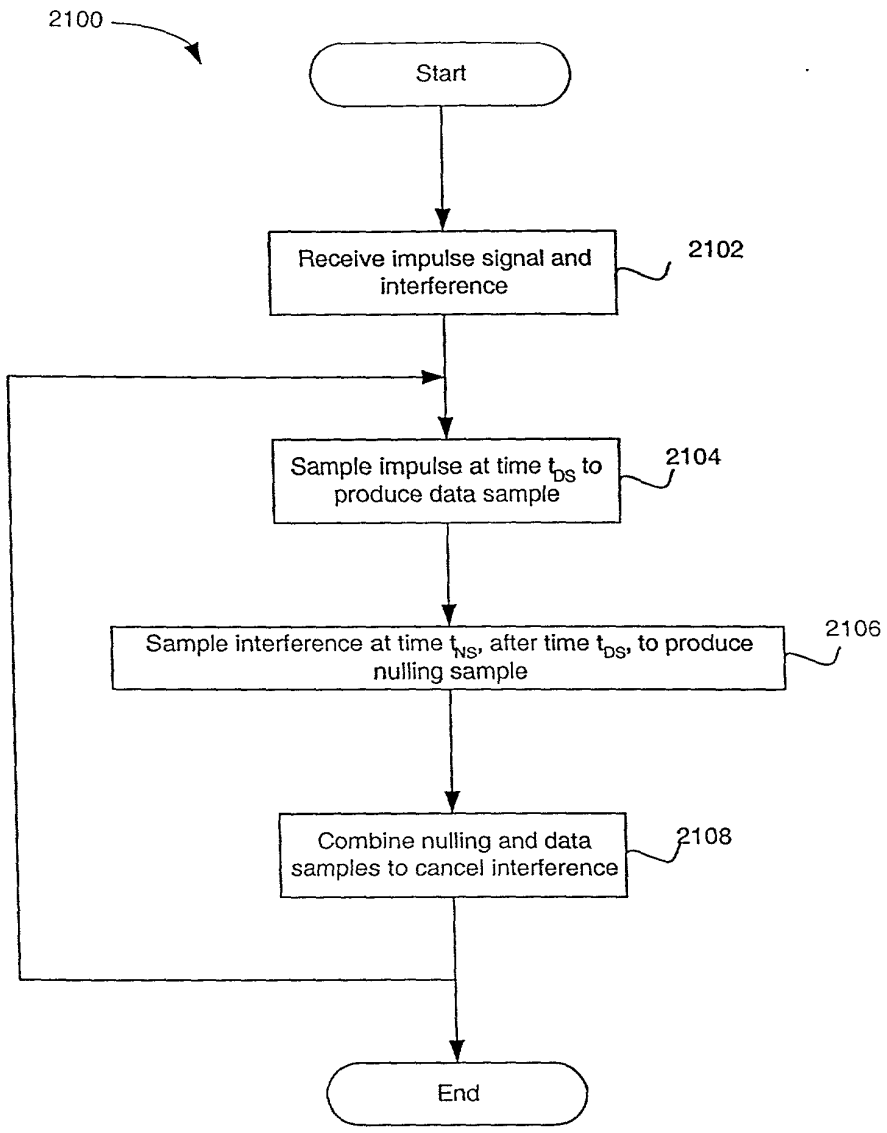

FIG. 21

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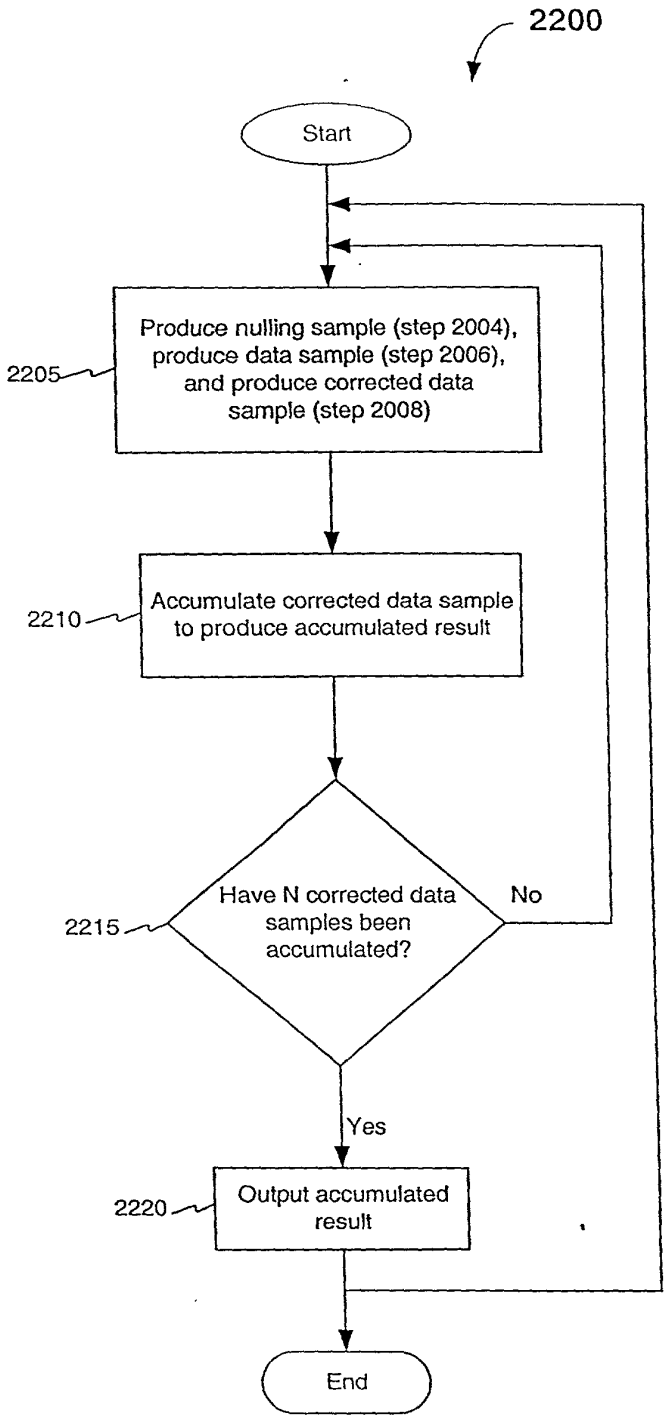

2200
Start
Produce nulling sample (step 2004), produce data sample (step 2006), and produce corrected data sample (step 2008)
2205
Accumulate corrected data sample to produce accumulated result
2210
Have N corrected data samples been accumulated?
2215
No
Yes
Output accumulated result
2220
End

FIG. 22

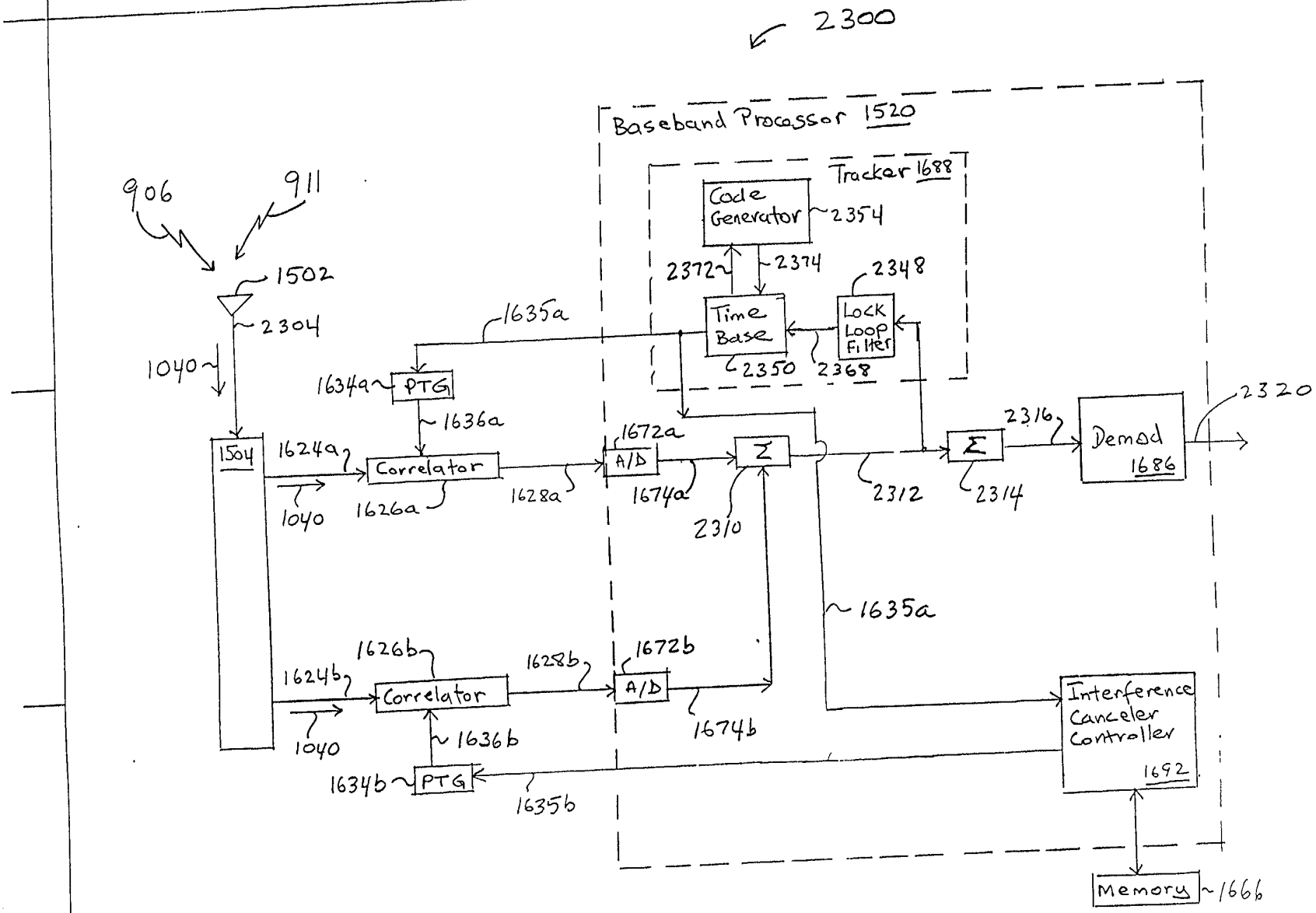

2300
Baseband Processor 1520
Tracker 1688
Code Generator
2354
2372
2374
2348
Time Base
Lock Loop Filter
2350
2368
1635a
906
911
1502
2304
1040
1634a
PTG
1636a
1504
1624a
Correlator
1628a
1672a
A/D
Σ
1674a
2310
2312
Σ
2316
Demod 1686
2320
1626a
1040
1626b
1624b
Correlator
1628b
1672b
A/D
1674b
1635a
Interference Canceler Controller 1692
1636b
1634b
PTG
1635b
Memory
1666

FIG. 23

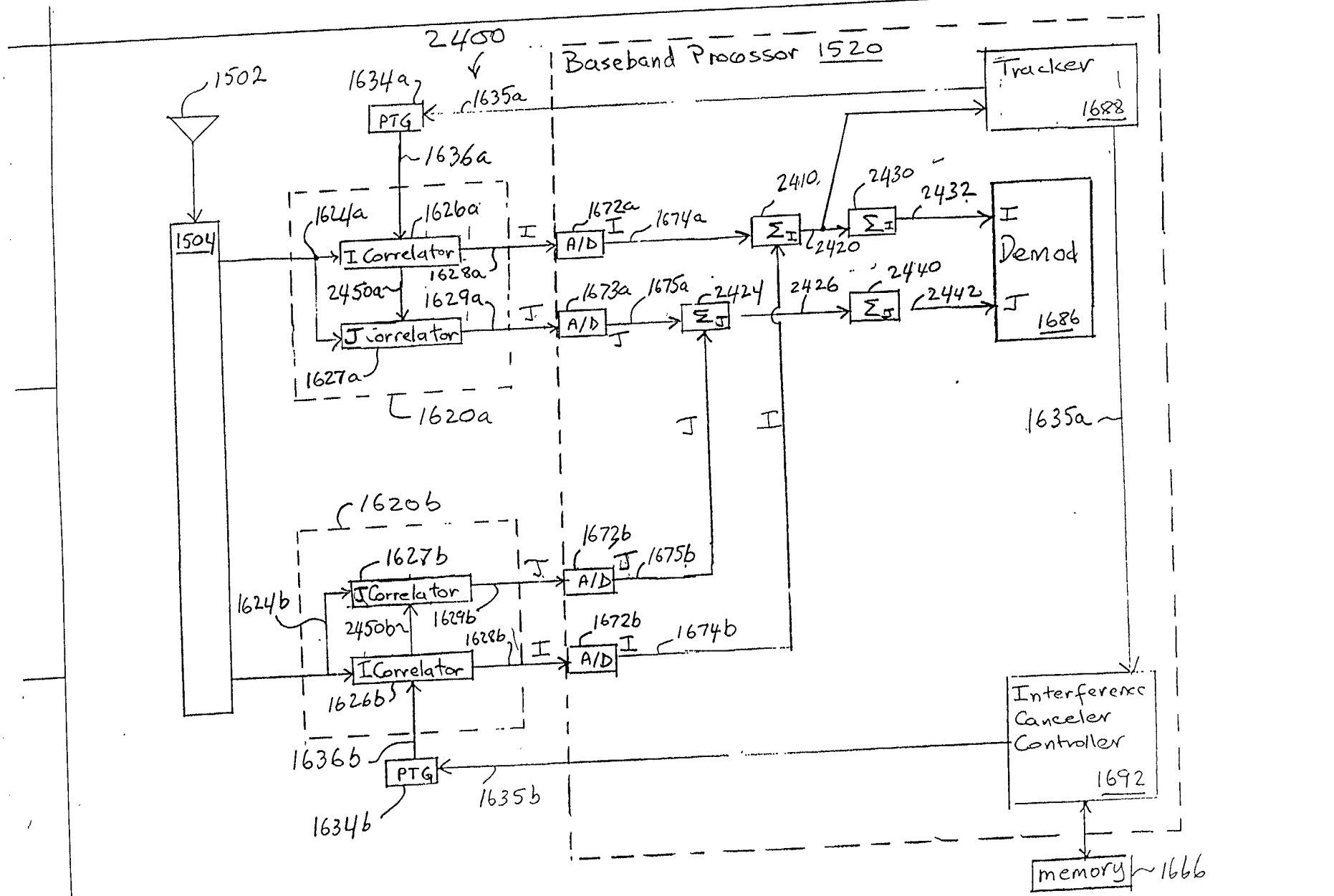

2400
Baseband Processor 1520
1502
1634a
PTG
1635a
1636a
Tracker
1688
1504
1624a
1626a
I Correlator
1628a
2450a
1629a
J Correlator
1627a
1620a
1672a
A/D
1674a
2410
2430
2432
2420
2440
2442
2426
2424
1673a
1675a
Demod
1686
1635a
1620b
1627b
1673b
1675b
1624b
2450b
1629b
1628b
1672b
1674b
1626b
1636b
1634b
1635b
Interference Canceler Controller
1692
memory
1666

FIG. 24

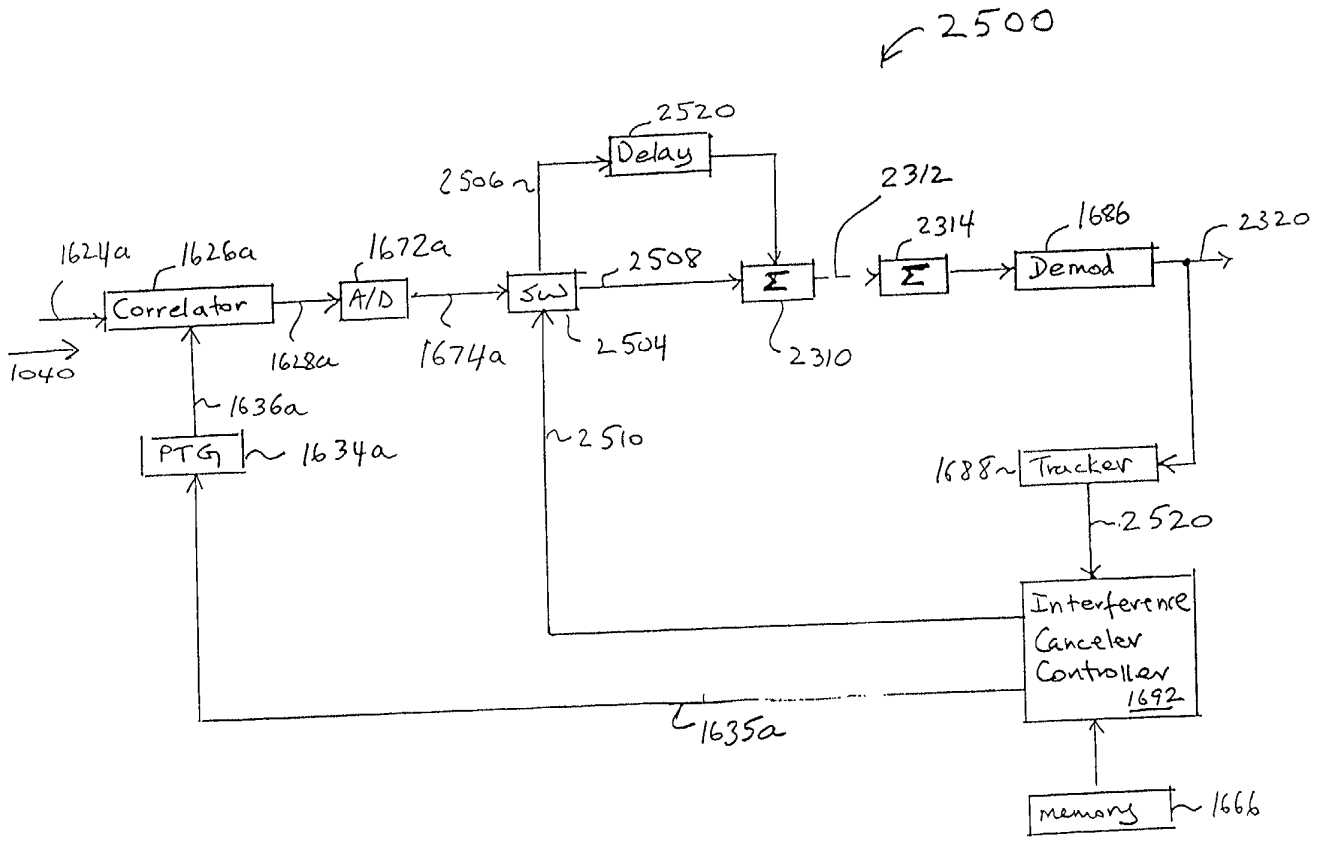

2500
2520
Delay
2506
2312
2314
1686
2320
1624a
1626a
1672a
2508
Correlator
A/D
SW
Σ
Σ
Demod
1628a
1674a
2504
2310
1040
1636a
PTG
1634a
2510
1688
Tracker
2520
Interference
Canceler
Controller
1692
1635a
memory
1666

FIG. 25

FIG. 26A

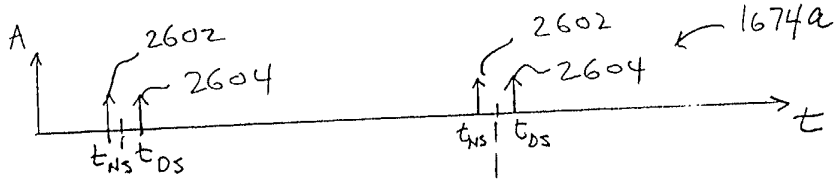


FIG. 26B

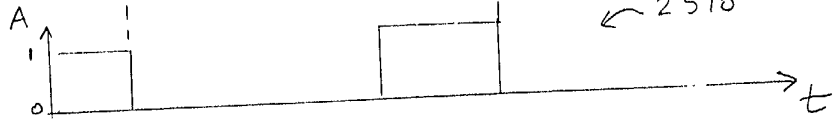
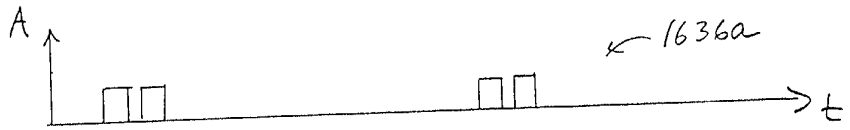


FIG. 26C



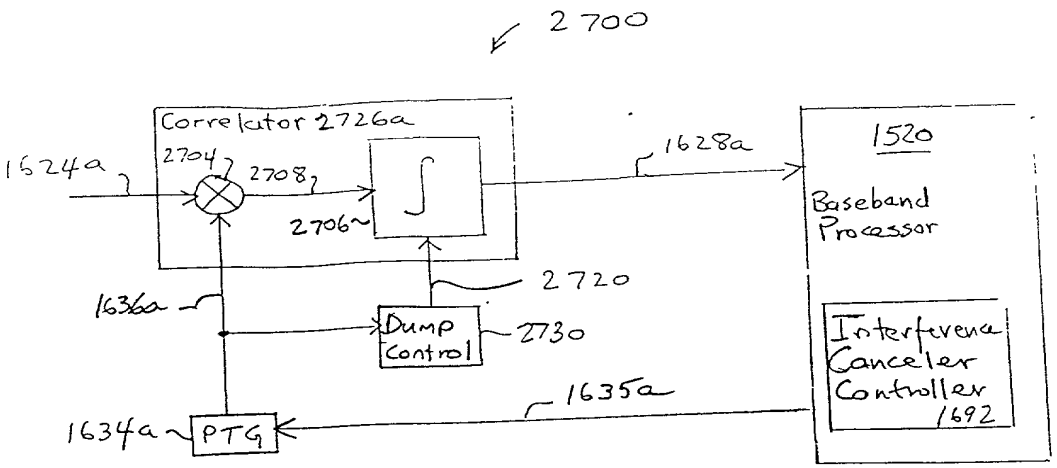

2700
Correlator 2726a
2704
2708
2706
1624a
1628a
1520
Baseband Processor
2720
1636a
Dump Control
2730
Interference Canceler Controller 1692
1635a
1634a
PTG

FIG. 27

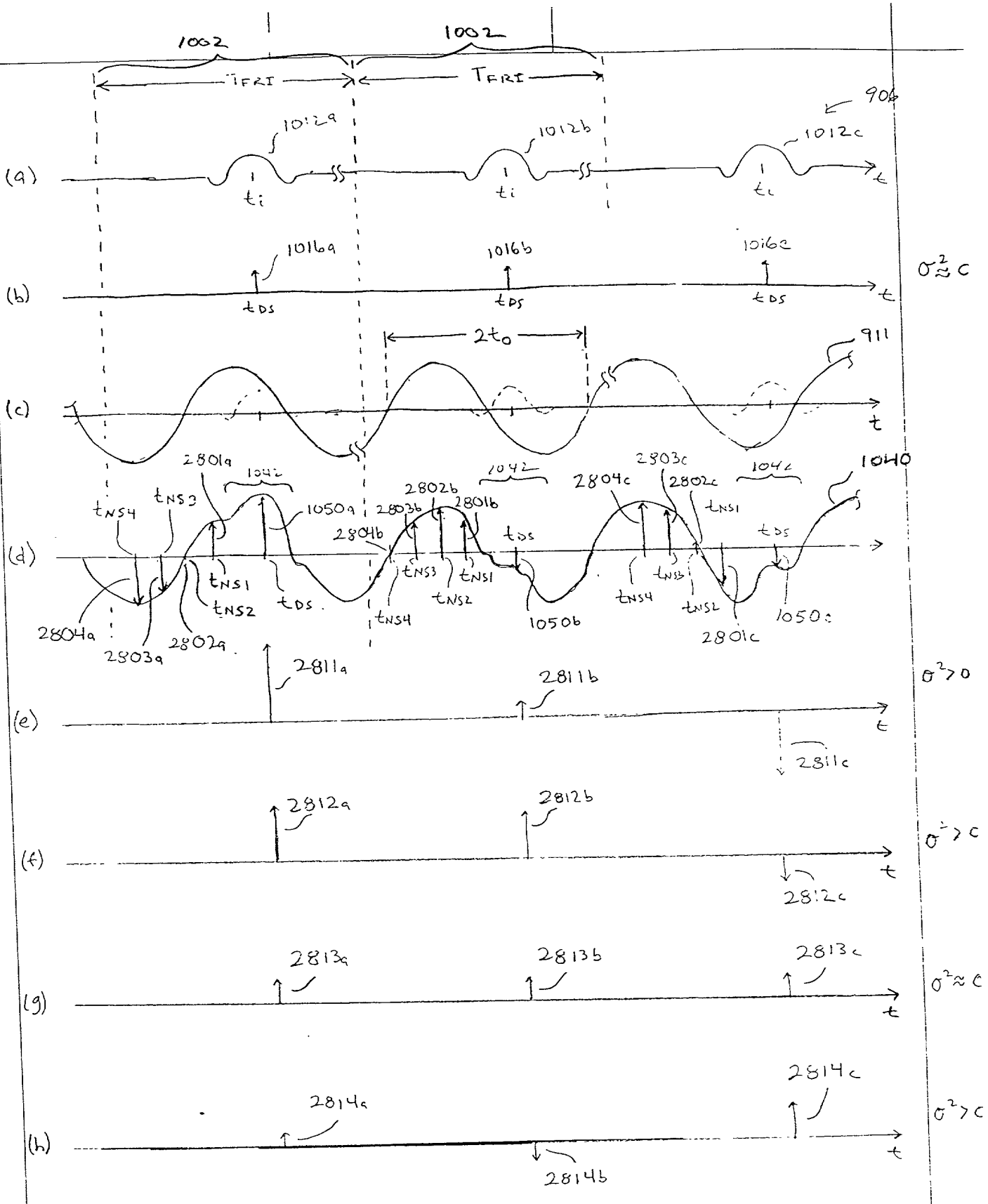

1002
1002
TFRI
TFRI
904
1012a
1012b
1012c
(a)
ti
ti
ti
t
1016a
1016b
1016c
(b)
tDS
tDS
tDS
t
σ² ≈ c
2t0
911
(c)
t
2801a
1042
tNS4
tNS3
1050a
2802b
2803b
2801b
1042
2804c
2803c
2802c
1042
1040
2804b
tDS
tNS1
tDS
(d)
tNS1
tNS2
tDS
tNS3
tNS1
tNS4
tNS2
tNS4
tNS3
tNS2
2804a
2803a
2802a
tNS4
1050b
2801c
1050c
2811a
2811b
σ² > 0
(e)
t
2811c
2812a
2812b
σ² > c
(f)
t
2812c
2813a
2813b
2813c
σ² ≈ c
(g)
t
2814c
2814a
σ² > c
(h)
t
2814b

FIG 28

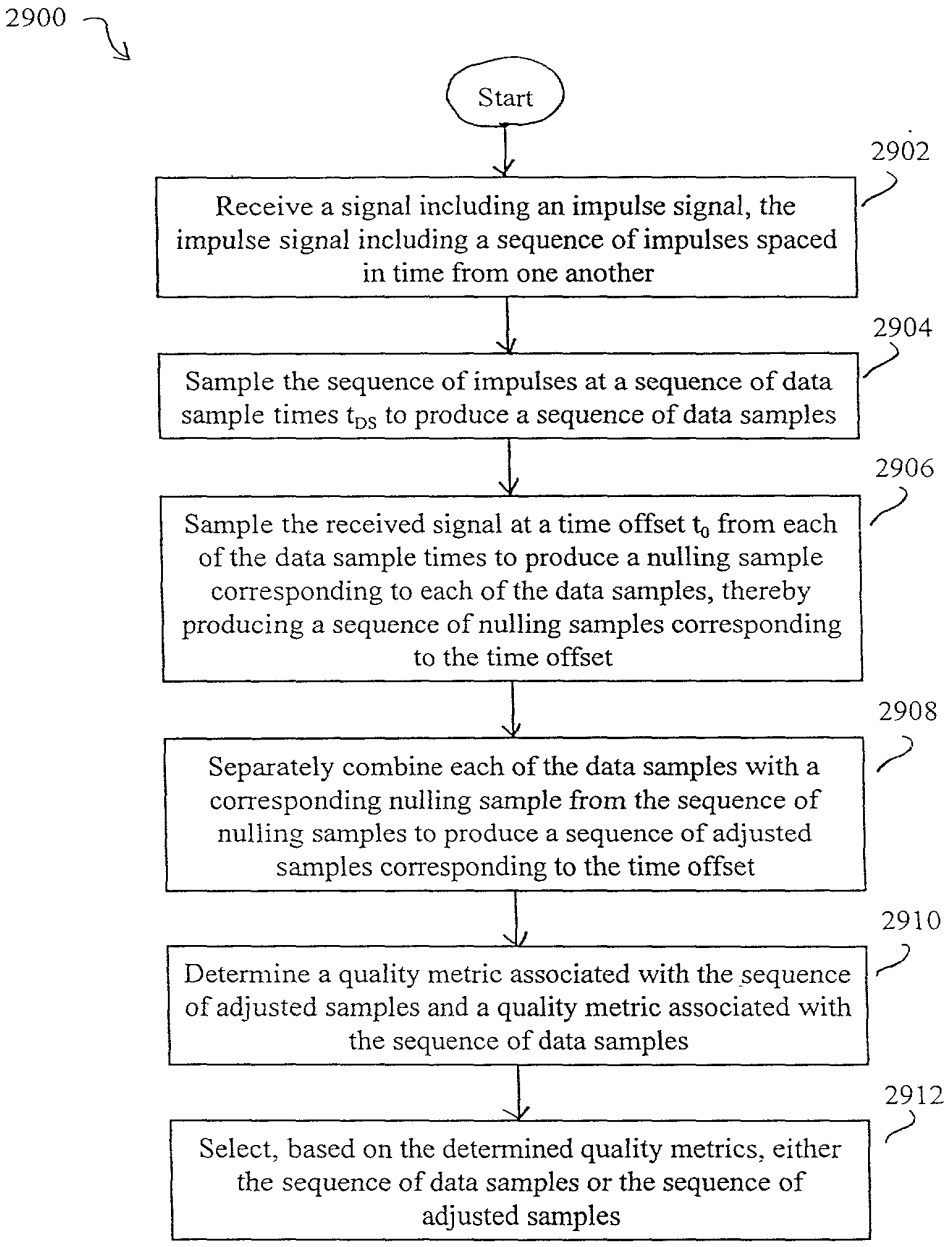

2900
Start
2902
Receive a signal including an impulse signal, the impulse signal including a sequence of impulses spaced in time from one another
2904
Sample the sequence of impulses at a sequence of data sample times t_{DS} to produce a sequence of data samples
2906
Sample the received signal at a time offset t_0 from each of the data sample times to produce a nulling sample corresponding to each of the data samples, thereby producing a sequence of nulling samples corresponding to the time offset
2908
Separately combine each of the data samples with a corresponding nulling sample from the sequence of nulling samples to produce a sequence of adjusted samples corresponding to the time offset
2910
Determine a quality metric associated with the sequence of adjusted samples and a quality metric associated with the sequence of data samples
2912
Select, based on the determined quality metrics, either the sequence of data samples or the sequence of adjusted samples

FIG. 29

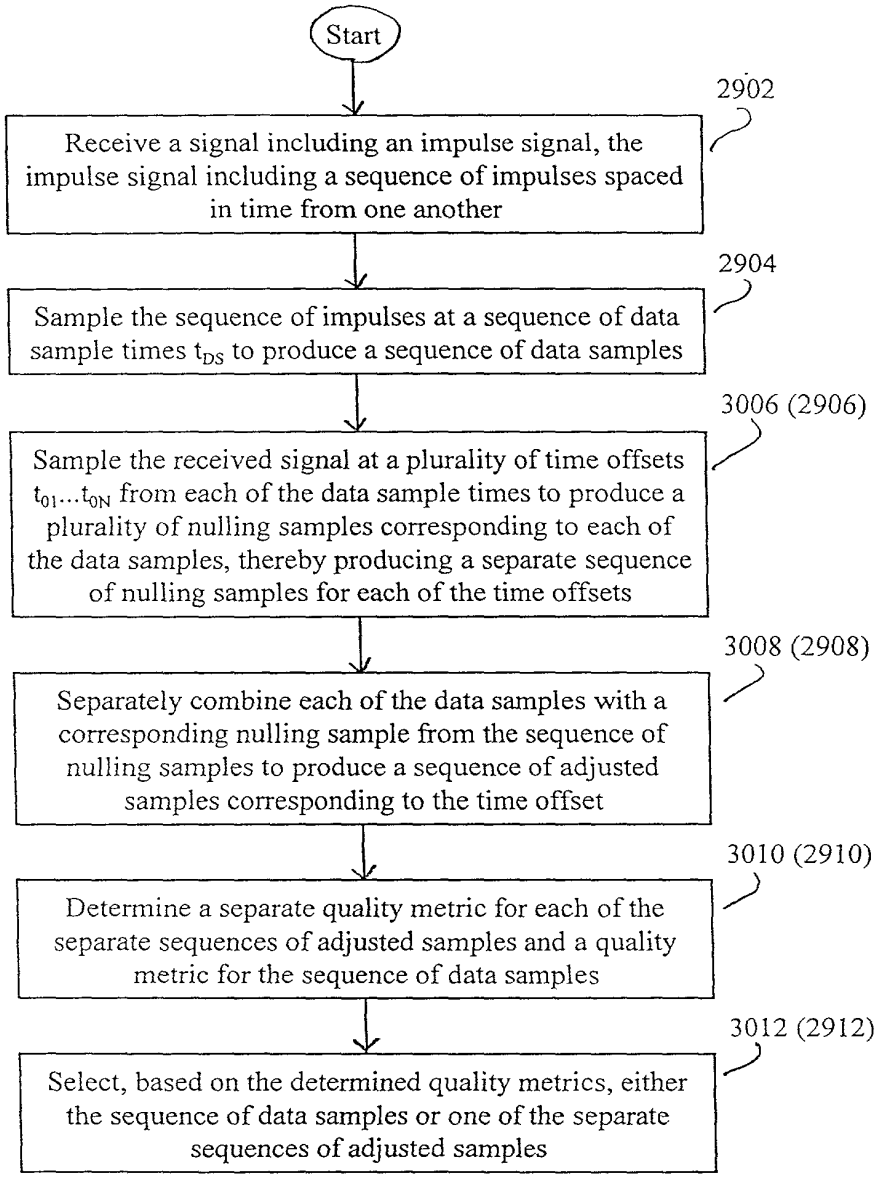

Start
2902
Receive a signal including an impulse signal, the impulse signal including a sequence of impulses spaced in time from one another
2904
Sample the sequence of impulses at a sequence of data sample times t_{DS} to produce a sequence of data samples
3006 (2906)
Sample the received signal at a plurality of time offsets $t_{01}...t_{0N}$ from each of the data sample times to produce a plurality of nulling samples corresponding to each of the data samples, thereby producing a separate sequence of nulling samples for each of the time offsets
3008 (2908)
Separately combine each of the data samples with a corresponding nulling sample from the sequence of nulling samples to produce a sequence of adjusted samples corresponding to the time offset
3010 (2910)
Determine a separate quality metric for each of the separate sequences of adjusted samples and a quality metric for the sequence of data samples
3012 (2912)
Select, based on the determined quality metrics, either the sequence of data samples or one of the separate sequences of adjusted samples

FIG. 30

PENDING CLASSIFIED

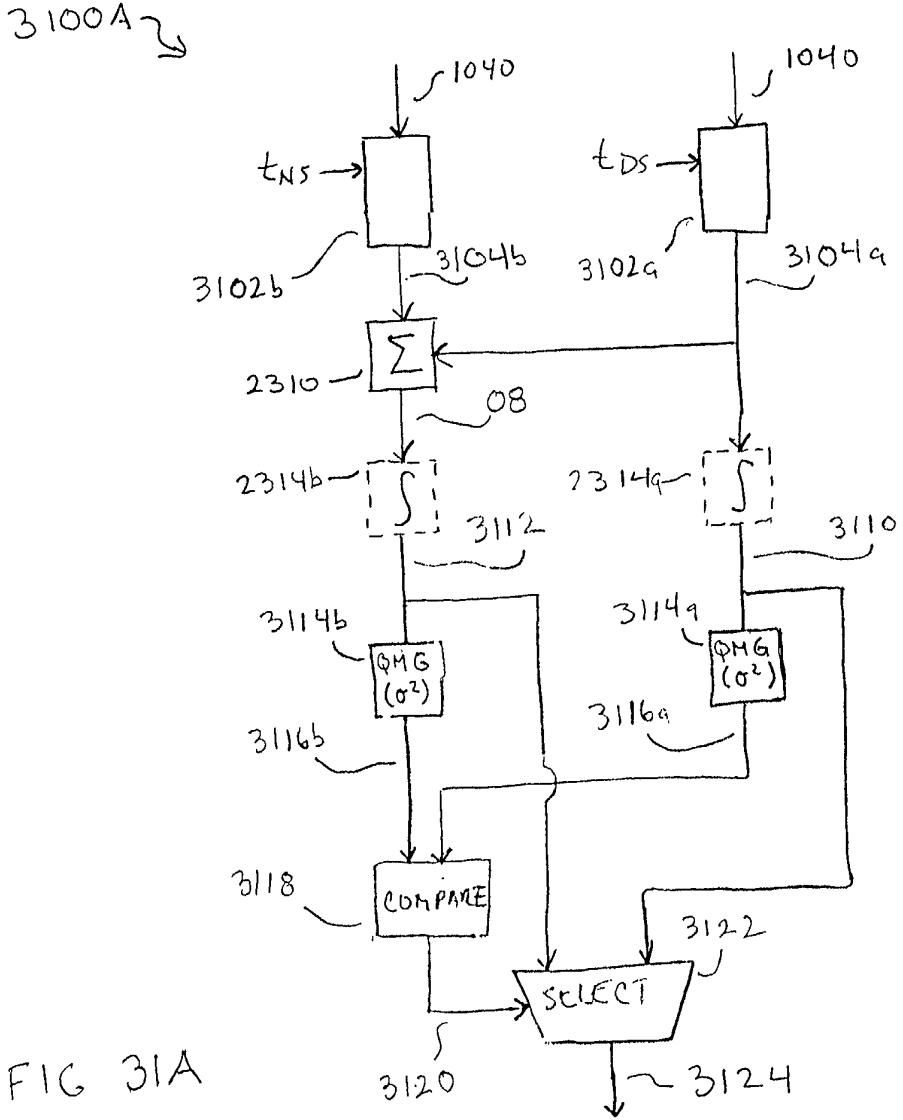


FIG 31A

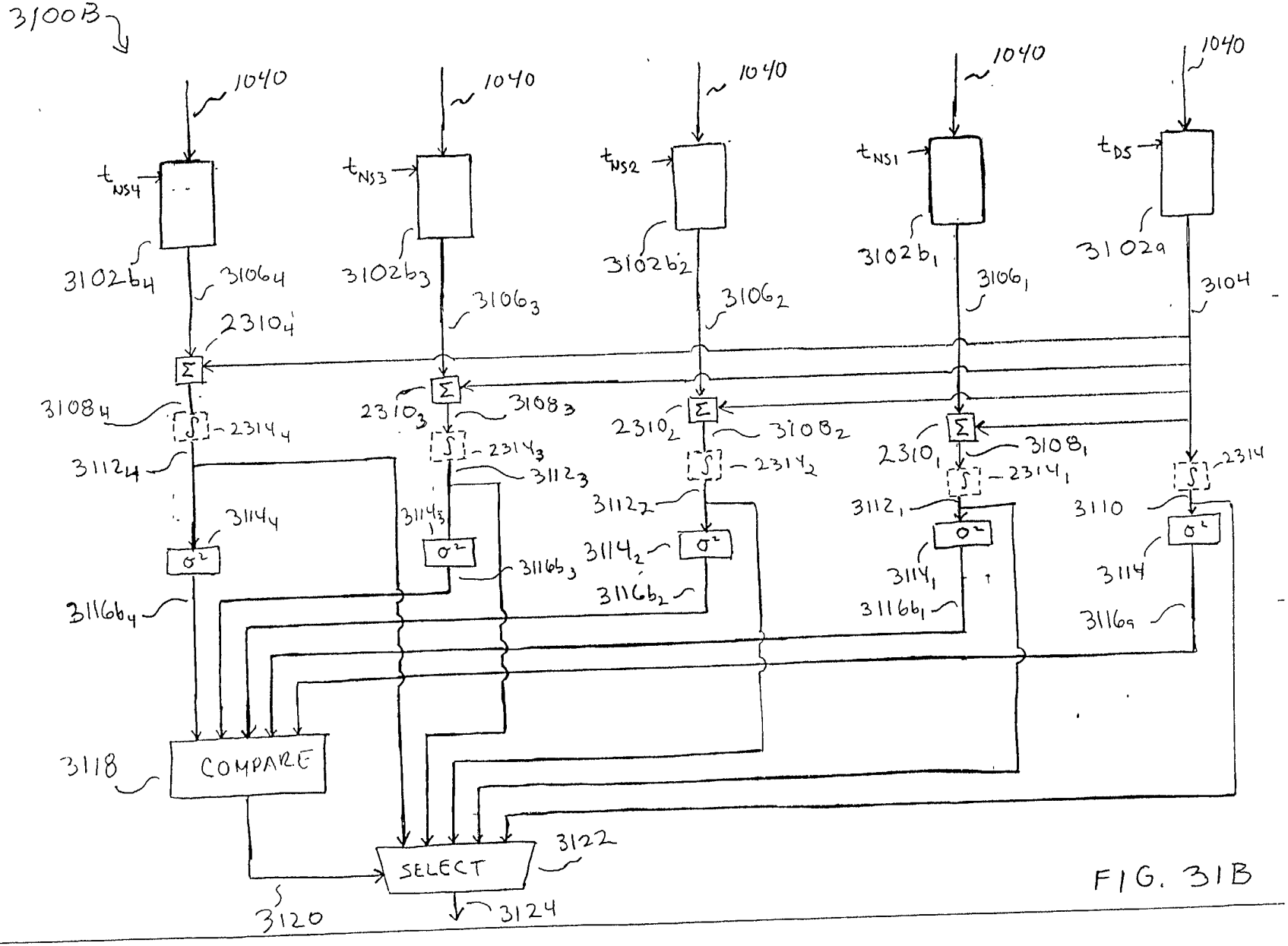

3100B
1040
1040
1040
1040
1040
t_{NS4}
t_{NS3}
t_{NS2}
t_{NS1}
t_{DS}
$3102b_4$
$3102b_3$
$3102b_2$
$3102b_1$
3102a
3106_4
3106_3
3106_2
3106_1
3104
2310_4
2310_3
2310_2
2310_1
2310
3108_4
3108_3
3108_2
3108_1
2314_4
2314_3
2314_2
2314_1
2314
3112_4
3112_3
3112_2
3112_1
3110
3114_4
3114_3
3114_2
3114_1
3114
σ^2
$3116b_4$
$3116b_3$
$3116b_2$
$3116b_1$
3116a
3118
COMPARE
3120
SELECT
3122
3124

FIG. 31B

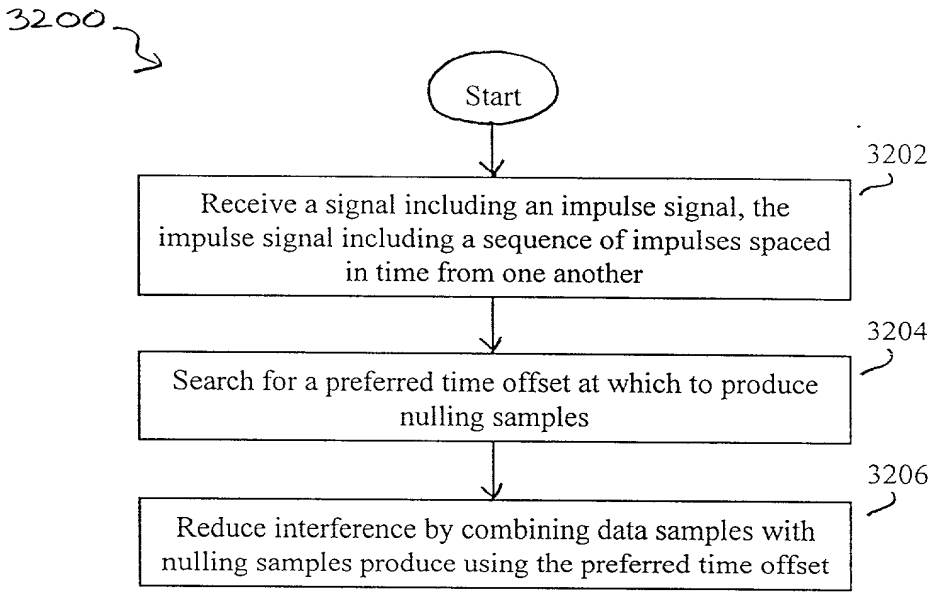

3200
Start
3202
Receive a signal including an impulse signal, the impulse signal including a sequence of impulses spaced in time from one another
3204
Search for a preferred time offset at which to produce nulling samples
3206
Reduce interference by combining data samples with nulling samples produce using the preferred time offset

FIG. 32

fig32

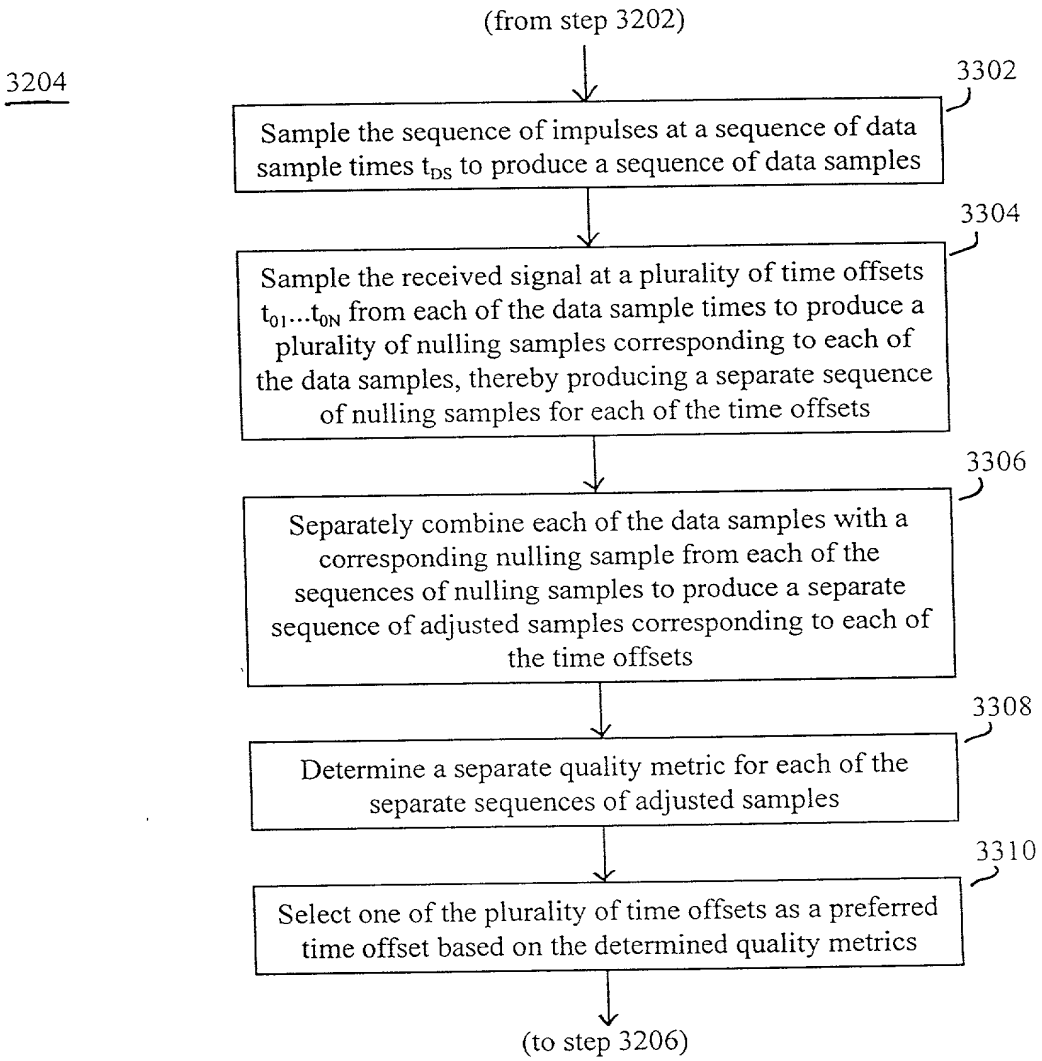

(from step 3202)
3204
3302
Sample the sequence of impulses at a sequence of data sample times t_{DS} to produce a sequence of data samples
3304
Sample the received signal at a plurality of time offsets $t_{01}...t_{0N}$ from each of the data sample times to produce a plurality of nulling samples corresponding to each of the data samples, thereby producing a separate sequence of nulling samples for each of the time offsets
3306
Separately combine each of the data samples with a corresponding nulling sample from each of the sequences of nulling samples to produce a separate sequence of adjusted samples corresponding to each of the time offsets
3308
Determine a separate quality metric for each of the separate sequences of adjusted samples
3310
Select one of the plurality of time offsets as a preferred time offset based on the determined quality metrics
(to step 3206)

FIG. 33

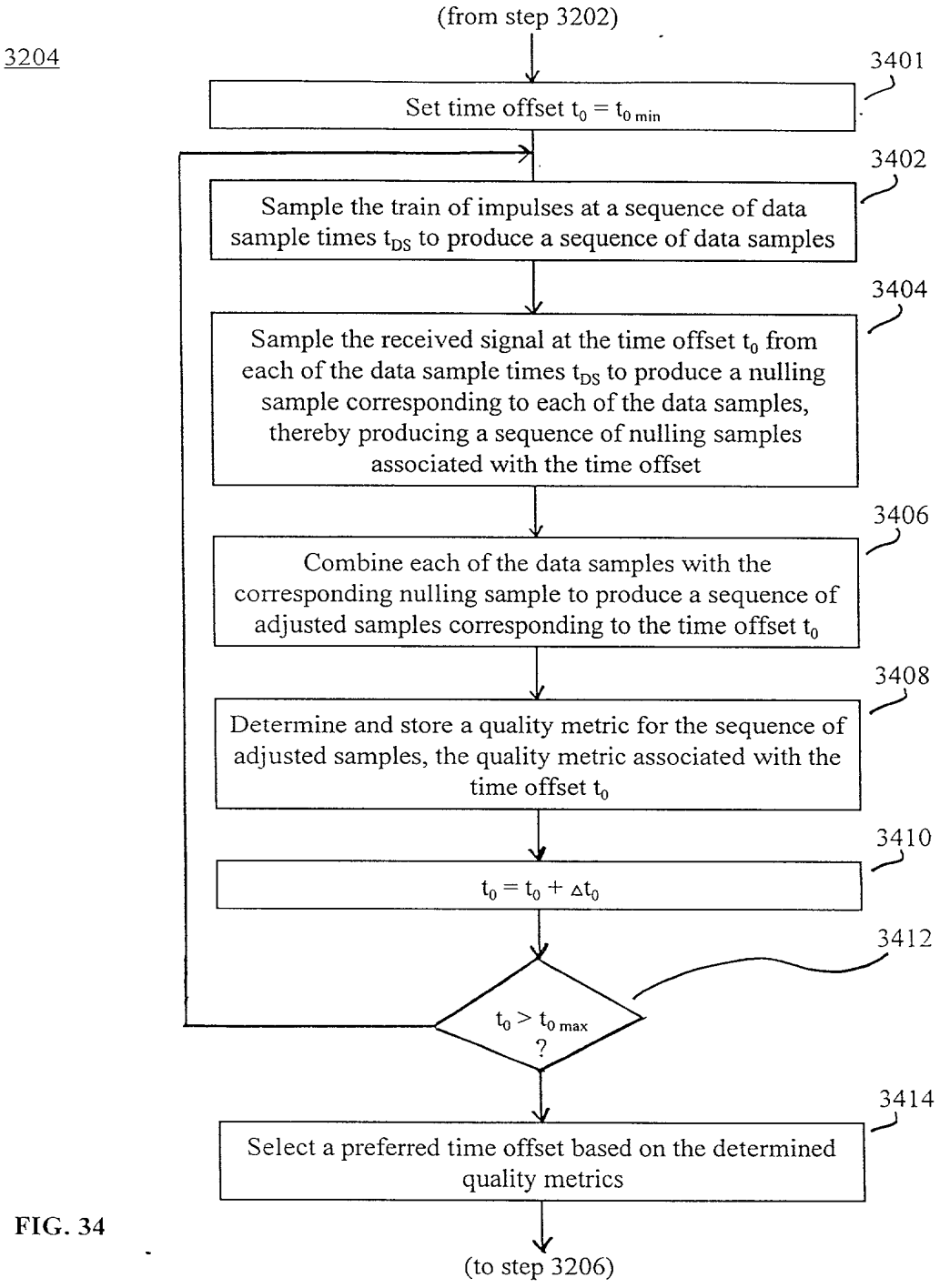

(from step 3202)
3204
3401
Set time offset $t_0 = t_{0\,min}$
3402
Sample the train of impulses at a sequence of data sample times t_{DS} to produce a sequence of data samples
3404
Sample the received signal at the time offset t_0 from each of the data sample times t_{DS} to produce a nulling sample corresponding to each of the data samples, thereby producing a sequence of nulling samples associated with the time offset
3406
Combine each of the data samples with the corresponding nulling sample to produce a sequence of adjusted samples corresponding to the time offset t_0
3408
Determine and store a quality metric for the sequence of adjusted samples, the quality metric associated with the time offset t_0
3410
$t_0 = t_0 + \Delta t_0$
3412
$t_0 > t_{0\,max}$?
3414
Select a preferred time offset based on the determined quality metrics
(to step 3206)

FIG. 34

fig34

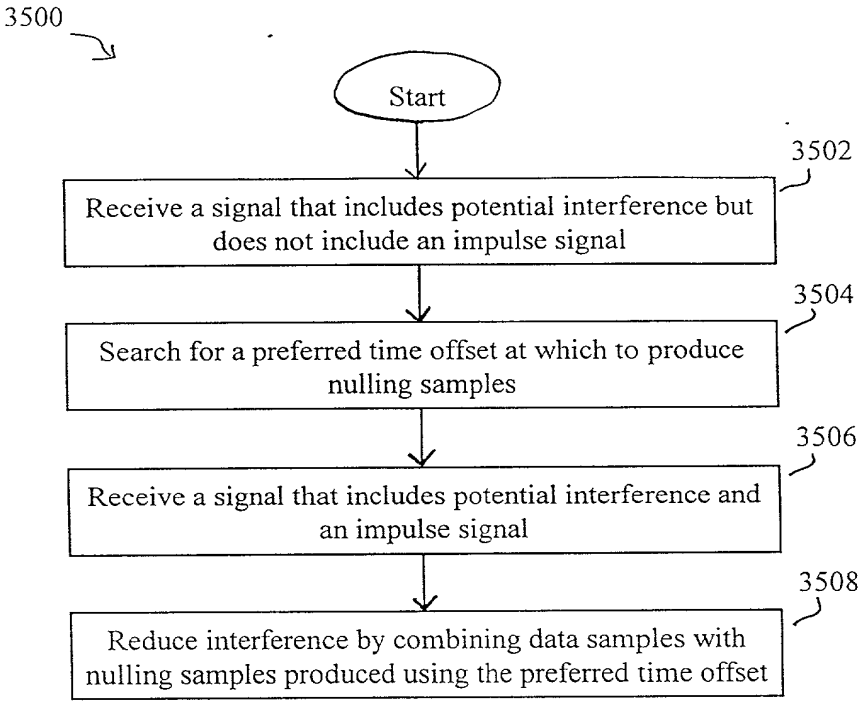

3500
Start
3502
Receive a signal that includes potential interference but does not include an impulse signal
3504
Search for a preferred time offset at which to produce nulling samples
3506
Receive a signal that includes potential interference and an impulse signal
3508
Reduce interference by combining data samples with nulling samples produced using the preferred time offset

FIG. 35

fig35

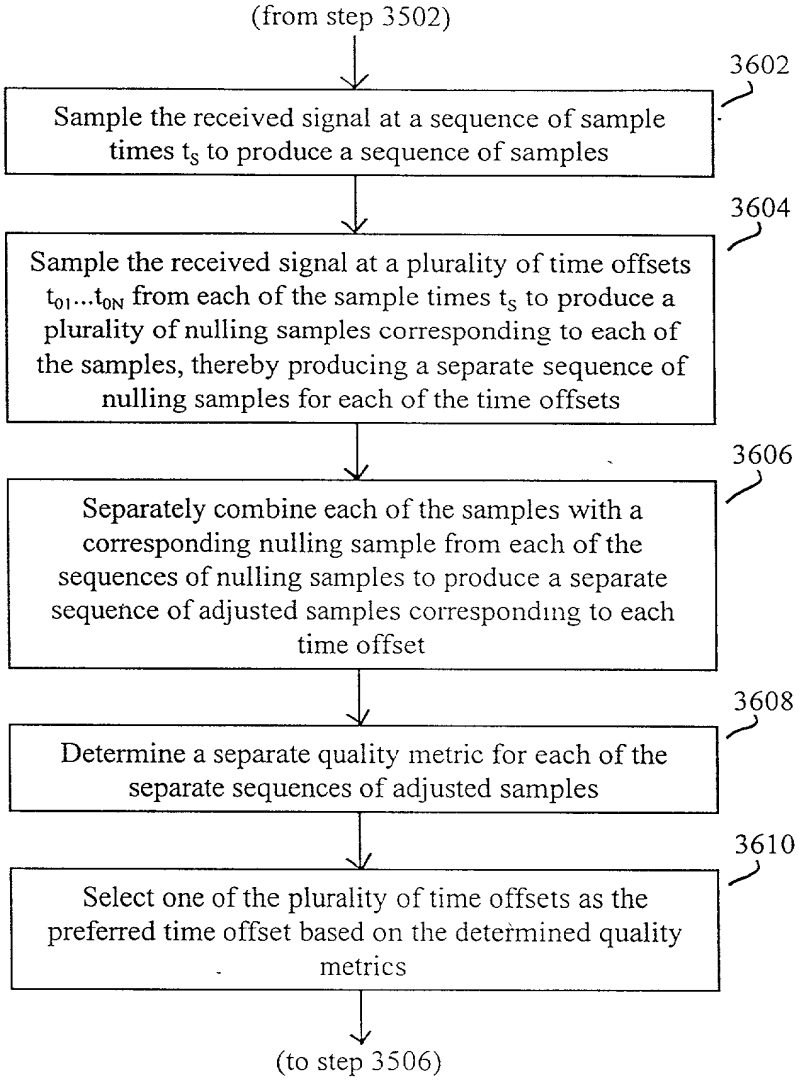

(from step 3502)
3504
3602
Sample the received signal at a sequence of sample times t_S to produce a sequence of samples
3604
Sample the received signal at a plurality of time offsets $t_{01}...t_{0N}$ from each of the sample times t_S to produce a plurality of nulling samples corresponding to each of the samples, thereby producing a separate sequence of nulling samples for each of the time offsets
3606
Separately combine each of the samples with a corresponding nulling sample from each of the sequences of nulling samples to produce a separate sequence of adjusted samples corresponding to each time offset
3608
Determine a separate quality metric for each of the separate sequences of adjusted samples
3610
Select one of the plurality of time offsets as the preferred time offset based on the determined quality metrics
(to step 3506)

FIG. 36

fig36

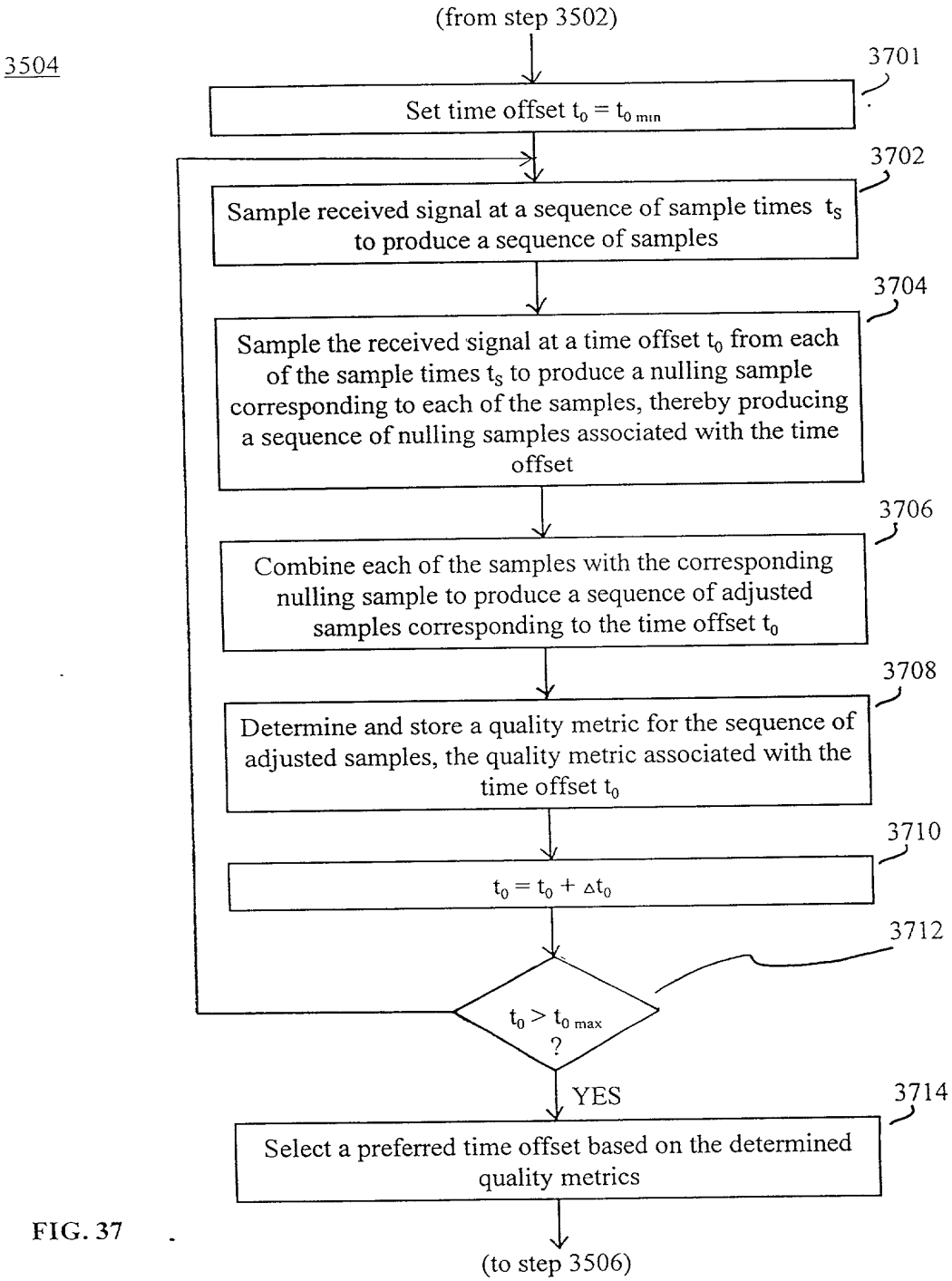

(from step 3502)
3504
3701
Set time offset $t_0 = t_{0\,min}$
3702
Sample received signal at a sequence of sample times t_S to produce a sequence of samples
3704
Sample the received signal at a time offset t_0 from each of the sample times t_S to produce a nulling sample corresponding to each of the samples, thereby producing a sequence of nulling samples associated with the time offset
3706
Combine each of the samples with the corresponding nulling sample to produce a sequence of adjusted samples corresponding to the time offset t_0
3708
Determine and store a quality metric for the sequence of adjusted samples, the quality metric associated with the time offset t_0
3710
$t_0 = t_0 + \Delta t_0$
3712
$t_0 > t_{0\,max}$?
YES
3714
Select a preferred time offset based on the determined quality metrics
(to step 3506)

FIG. 37

fig37

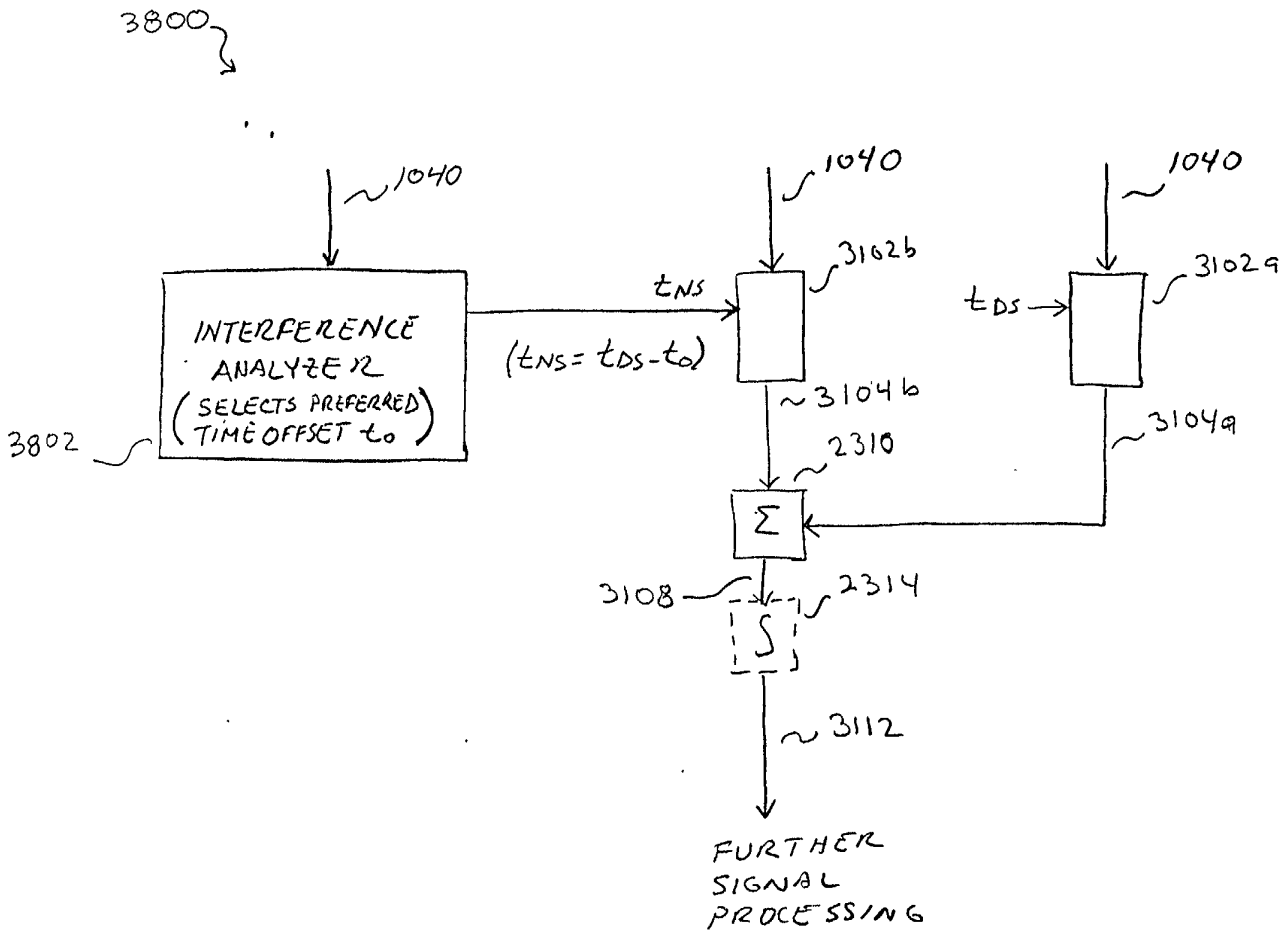

3800
1040
1040
1040
INTERFERENCE ANALYZER (SELECTS PREFERRED TIME OFFSET t_o)
3802
t_{NS}
$(t_{NS} = t_{DS} - t_o)$
3102b
3102a
t_{DS}
3104b
3104a
2310
Σ
3108
2314
3112
FURTHER SIGNAL PROCESSING

FIG. 38

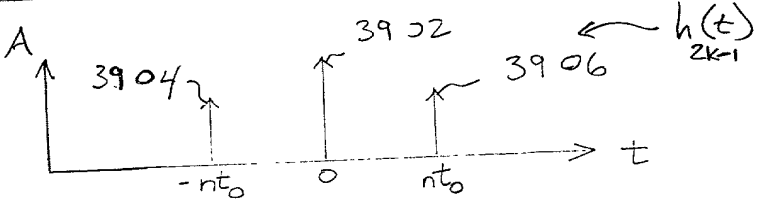


FIG. 39A

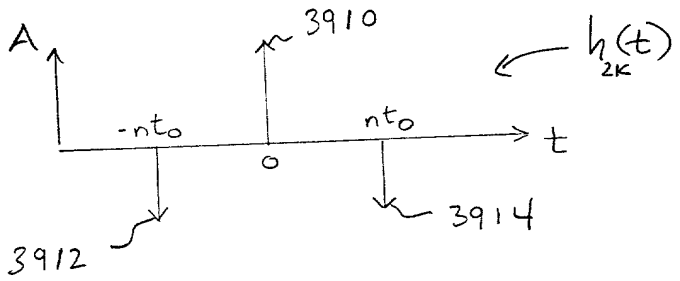


FIG. 39B

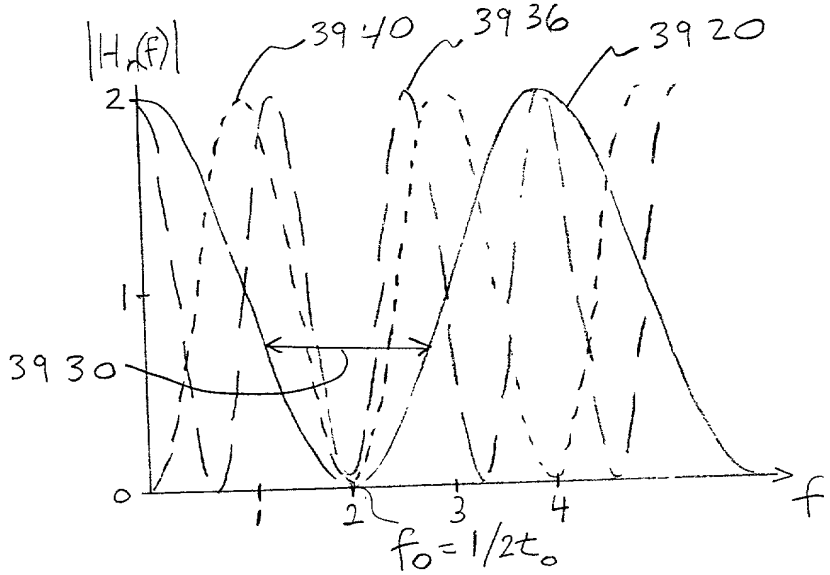


FIG. 39C

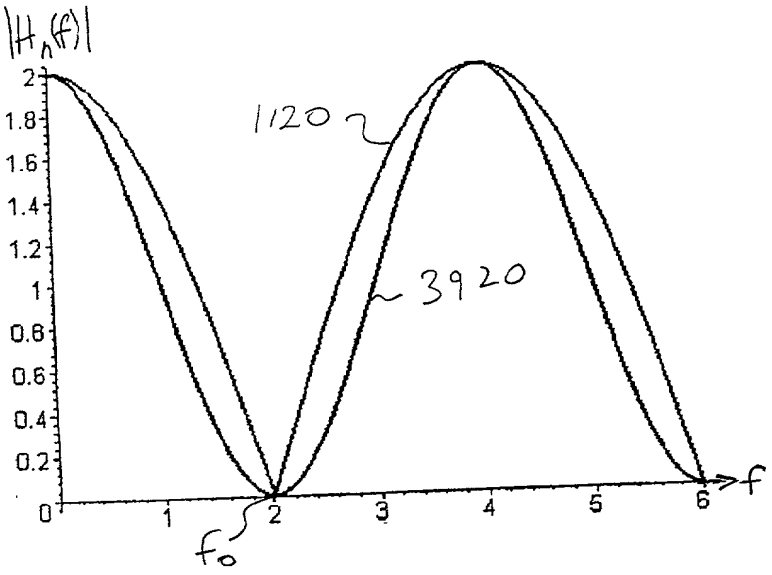


FIG. 39 D

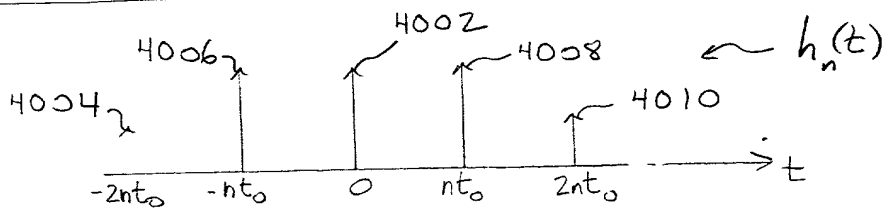
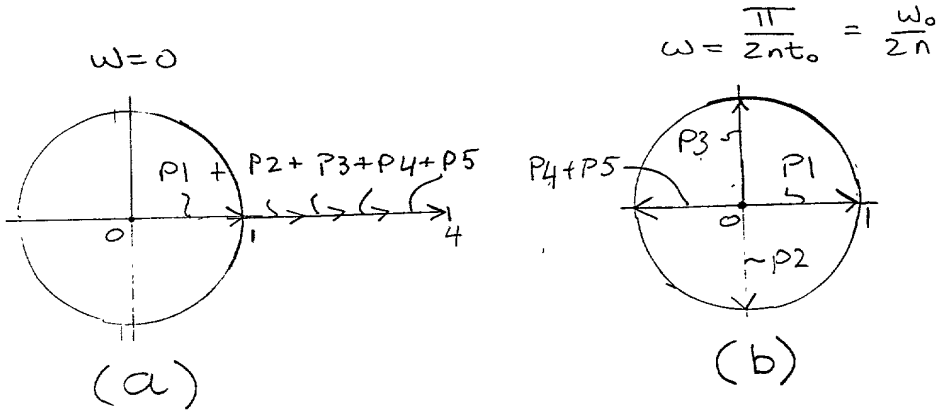
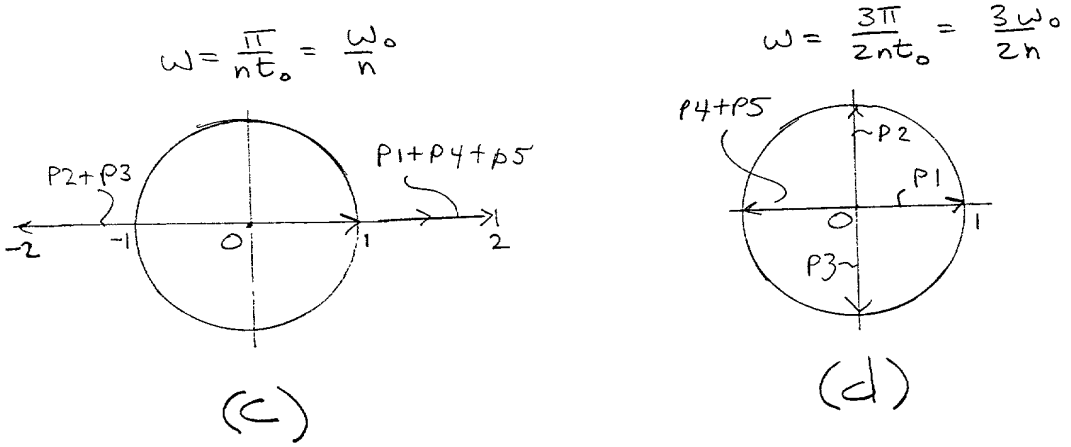


FIG. 40





$$F_n(\omega) = \underbrace{1}_{P1} + \underbrace{e^{-i\omega nt_o}}_{P2} + \underbrace{e^{i\omega nt_o}}_{P3} + \underbrace{\tfrac{1}{2}e^{-2i\omega nt_o}}_{P4} + \underbrace{\tfrac{1}{2}e^{2i\omega nt_o}}_{P5}$$

FIG. 41

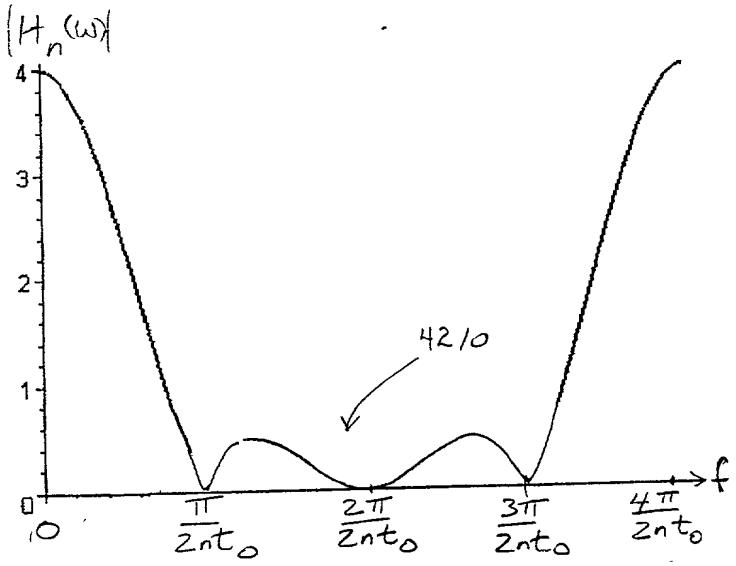

$|H_n(\omega)|$
4
3
2
1
0
4210
f
0
$\frac{\pi}{2nt_o}$
$\frac{2\pi}{2nt_o}$
$\frac{3\pi}{2nt_o}$
$\frac{4\pi}{2nt_o}$

FIG. 42

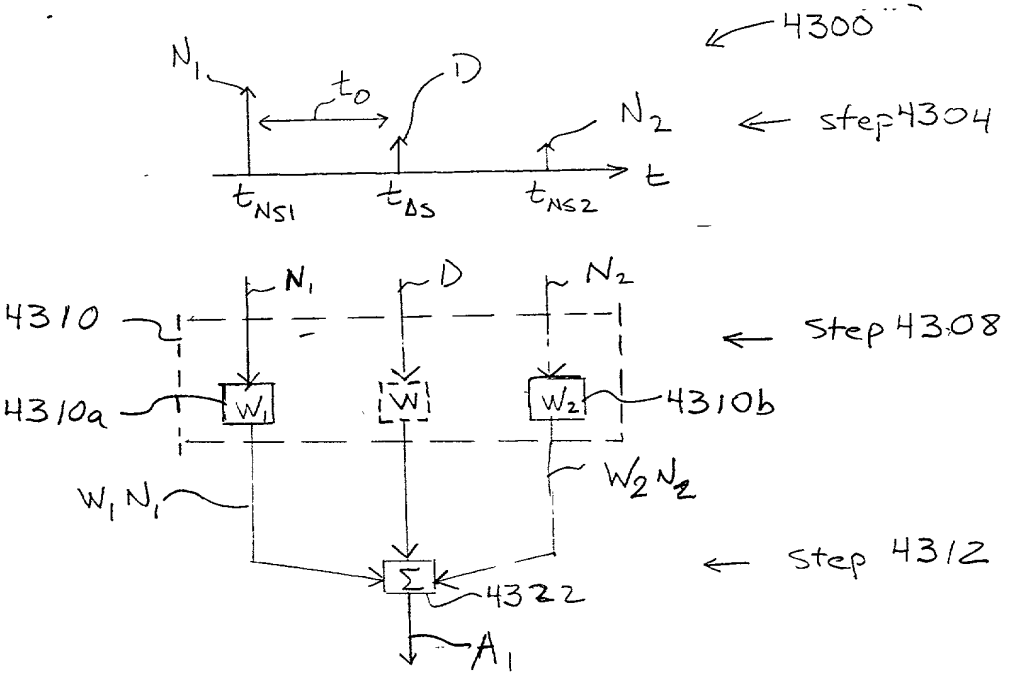

4300
N_1
t_0
D
N_2
step 4304
t
t_{NS1}
t_{DS}
t_{NS2}
N_1
D
N_2
4310
step 4308
4310a
W_1
W
W_2
4310b
$W_2 N_2$
$W_1 N_1$
step 4312
Σ
4322
A_1

FIG. 43

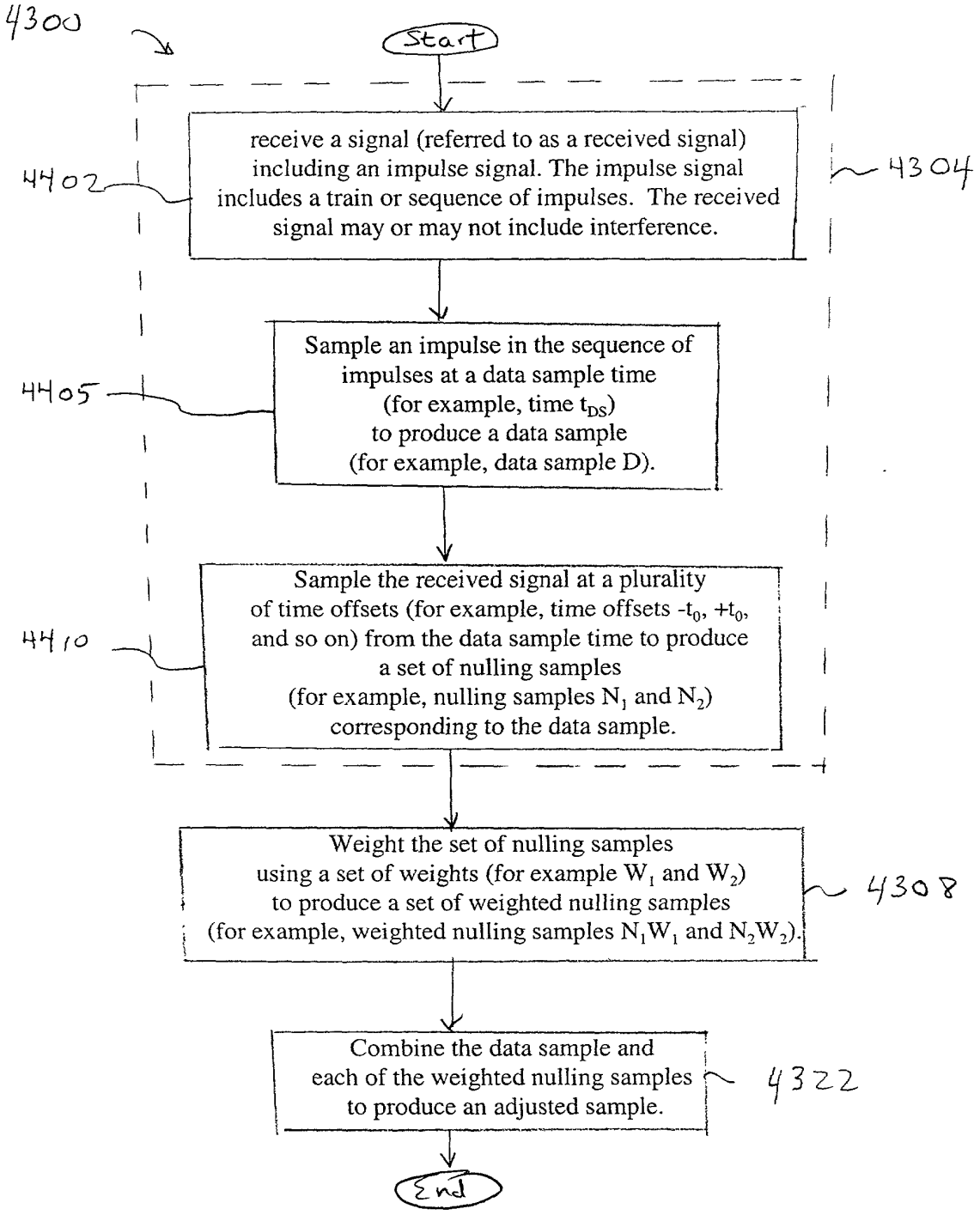

4300
Start
receive a signal (referred to as a received signal) including an impulse signal. The impulse signal includes a train or sequence of impulses. The received signal may or may not include interference.
4402
4304
Sample an impulse in the sequence of impulses at a data sample time (for example, time t_{DS}) to produce a data sample (for example, data sample D).
4405
Sample the received signal at a plurality of time offsets (for example, time offsets $-t_0$, $+t_0$, and so on) from the data sample time to produce a set of nulling samples (for example, nulling samples N_1 and N_2) corresponding to the data sample.
4410
Weight the set of nulling samples using a set of weights (for example W_1 and W_2) to produce a set of weighted nulling samples (for example, weighted nulling samples N_1W_1 and N_2W_2).
4308
Combine the data sample and each of the weighted nulling samples to produce an adjusted sample.
4322
End

FIG. 44

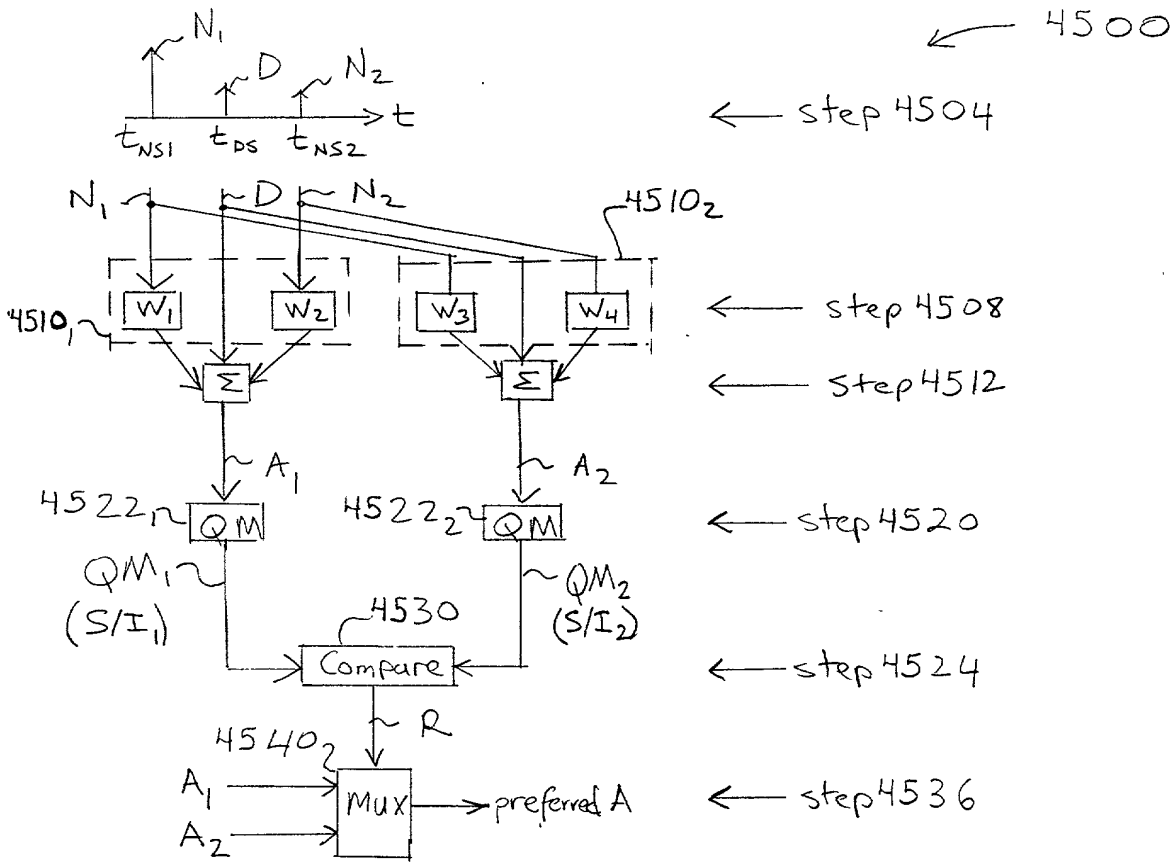
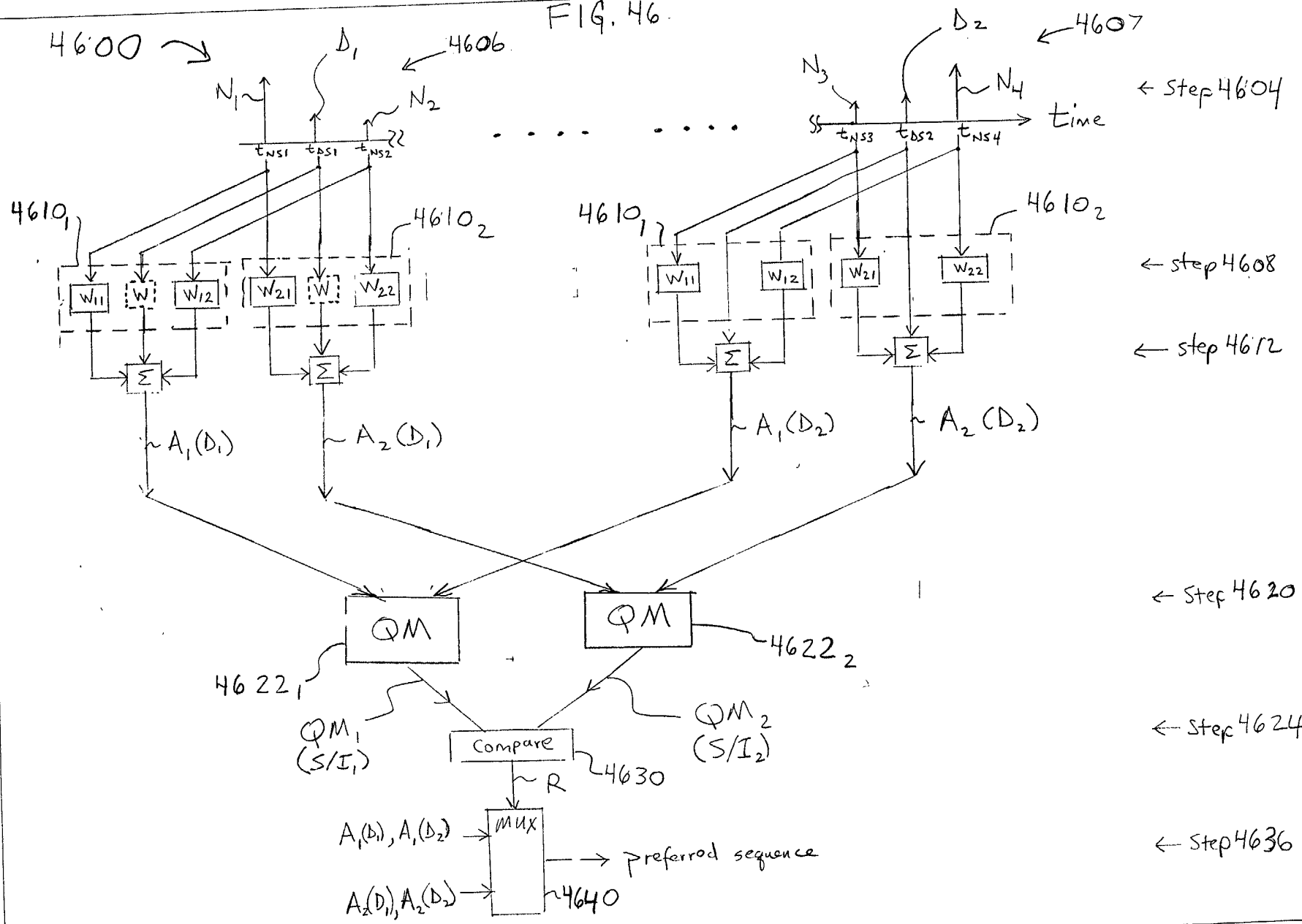

4500
N1
D
N2
t
tNS1
tDS
tNS2
step 4504
4510₂
W1
W2
W3
W4
4510₁
step 4508
Σ
step 4512
A1
A2
4522₁
QM
4522₂
step 4520
QM1
(S/I1)
QM2
(S/I2)
4530
Compare
step 4524
R
4540₂
MUX
preferred A
step 4536

FIG. 45

FIG. 46


4600
D_1
4606
N_1
N_2
t_{NS1} t_{DS1} t_{NS2}
4610_1
4610_2
W_{11} W W_{12} W_{21} W W_{22}
Σ
$A_1(D_1)$
$A_2(D_1)$
D_2
4607
N_3
N_4
time
t_{NS3} t_{DS2} t_{NS4}
4610_1
4610_2
W_{11} W_{12} W_{21} W_{22}
Σ
$A_1(D_2)$
$A_2(D_2)$
QM
QM
4622_1
4622_2
QM_1 (S/I_1)
QM_2 (S/I_2)
Compare
4630
R
$A_1(D_1), A_1(D_2)$
$A_2(D_1), A_2(D_2)$
MUX
preferrod sequence
4640
← step 4604
← step 4608
← step 4612
← step 4620
← step 4624
← step 4636

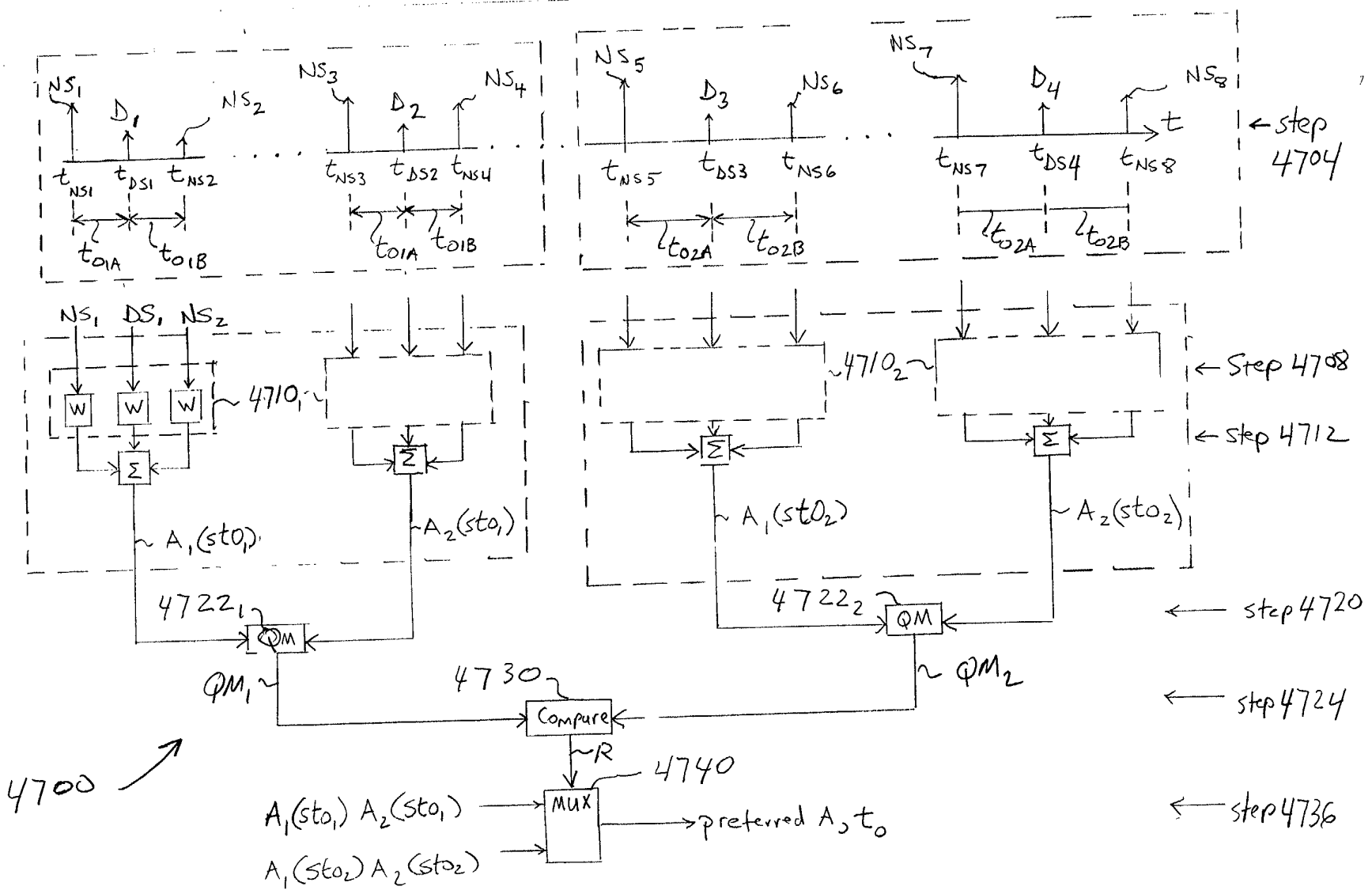

NS1
D1
NS2
NS3
D2
NS4
NS5
D3
NS6
NS7
D4
NS8
t
step 4704
tNS1 tDS1 tNS2 tNS3 tDS2 tNS4 tNS5 tDS3 tNS6 tNS7 tDS4 tNS8
to1A to1B to1A to1B to2A to2B to2A to2B
NS1 DS1 NS2
W W W
4710₁
4710₂
Step 4708
step 4712
Σ
A1(sto1) A2(sto1) A1(sto2) A2(sto2)
4722₁
4722₂
QM
QM1 QM2
step 4720
4730
Compare
step 4724
R
4740
MUX
A1(sto1) A2(sto1)
A1(sto2) A2(sto2)
preferred A, to
step 4736
4700

FIG. 47

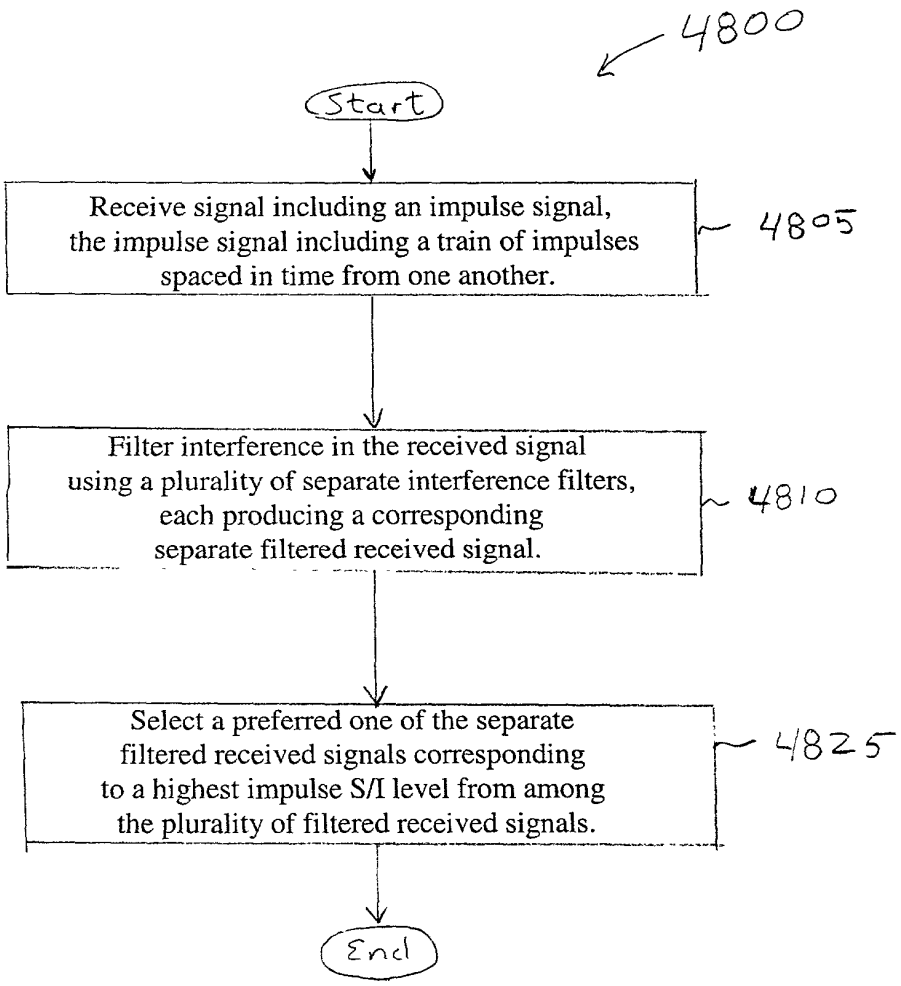

4800
Start
Receive signal including an impulse signal, the impulse signal including a train of impulses spaced in time from one another.
4805
Filter interference in the received signal using a plurality of separate interference filters, each producing a corresponding separate filtered received signal.
4810
Select a preferred one of the separate filtered received signals corresponding to a highest impulse S/I level from among the plurality of filtered received signals.
4825
End

FIG. 48

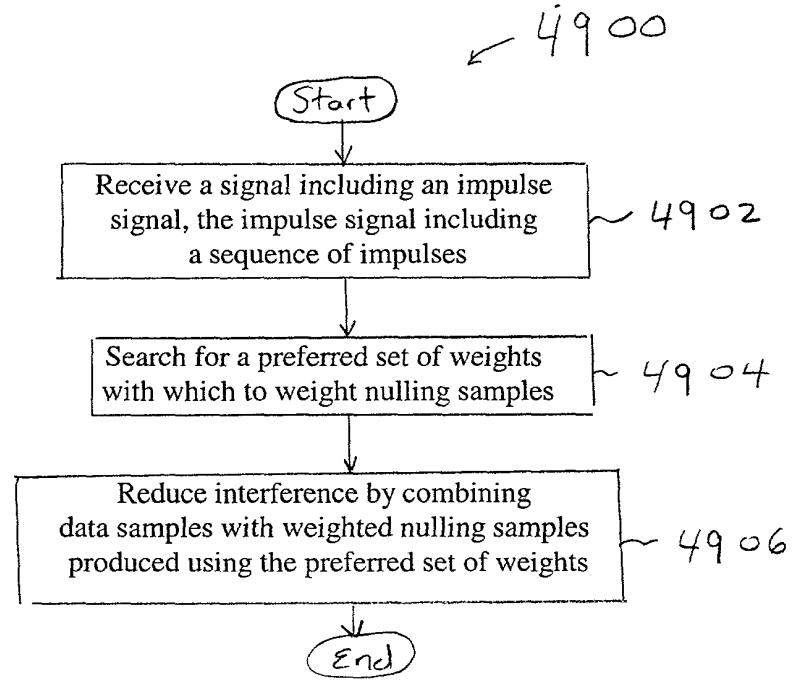

4900
Start
Receive a signal including an impulse signal, the impulse signal including a sequence of impulses
4902
Search for a preferred set of weights with which to weight nulling samples
4904
Reduce interference by combining data samples with weighted nulling samples produced using the preferred set of weights
4906
End

FIG. 49

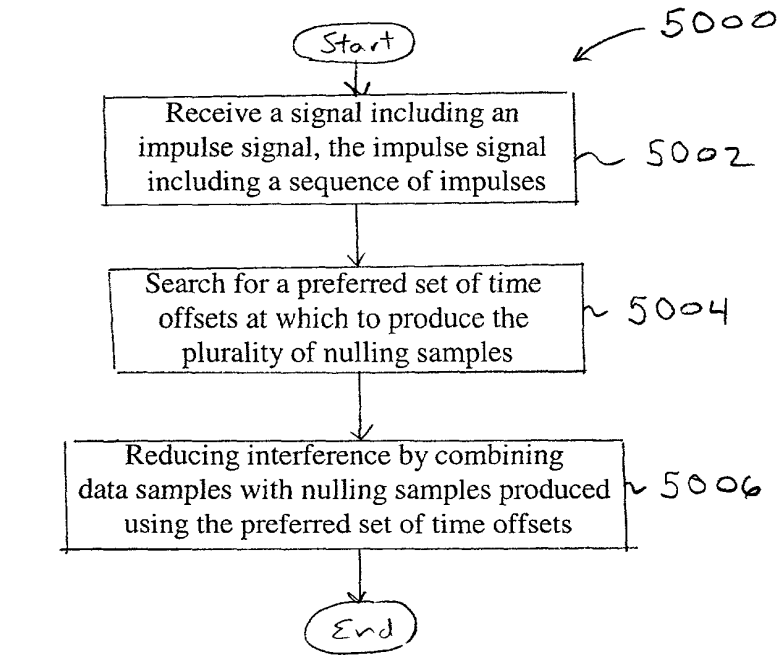

5000
Start
Receive a signal including an impulse signal, the impulse signal including a sequence of impulses
5002
Search for a preferred set of time offsets at which to produce the plurality of nulling samples
5004
Reducing interference by combining data samples with nulling samples produced using the preferred set of time offsets
5006
End

FIG. 50

FIG. 5

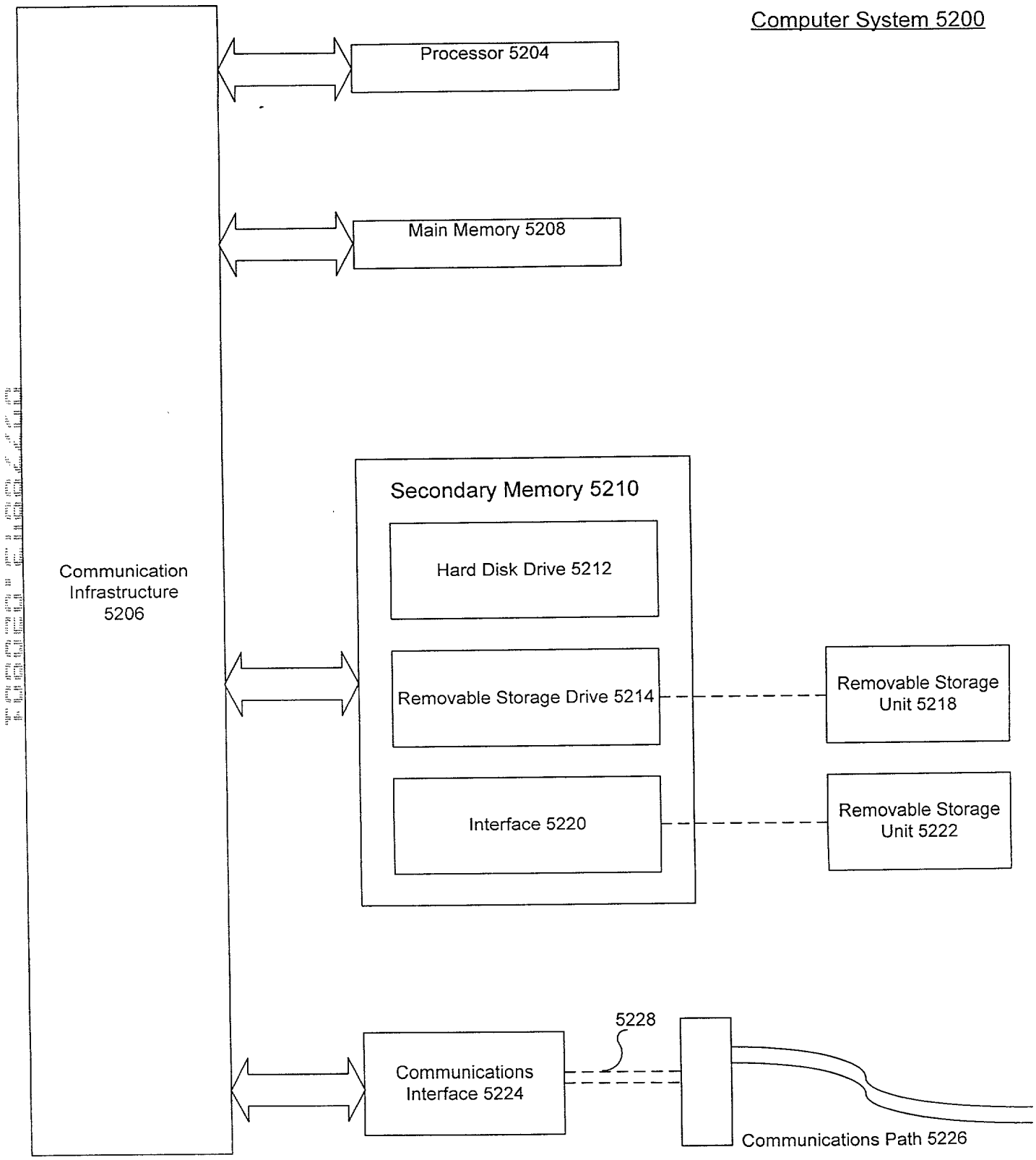


FIG. 52

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